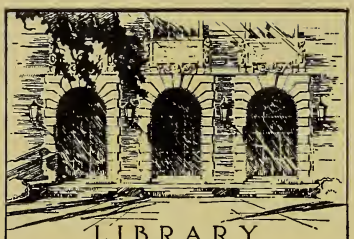

Marquette University

BULLETIN

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MARCH, 1918
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1918

JANUARY

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FEBRUARY

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MARCH

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1919

JANUARY

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MARCH

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JULY

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AUGUST

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SEPTEMBER

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OCTOBER

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NOVEMBER

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DECEMBER

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CALENDAR 1918-1919.

1918

Sept. 23-24-25.....Monday, Tuesday, Wednesday; entrance and condition examinations.
Sept. 27-30.....Friday, Monday; registration.
Oct. 1.....Tuesday, 8 A. M.; classes begin.
Nov. 27.....Wednesday, 5:00 P. M.; Thanksgiving recess begins.
Dec. 2.....Monday, 8:00 A. M.; classes resumed.
Dec. 21.....Saturday, 12:00 M.; Christmas recess begins.

1919

Jan. 5.....Monday, 8:00 A. M.; classes resumed.
Jan. 27-28-29-30 .....Monday to Thursday incl.; semester examinations.
Jan. 29-30.....Wednesday, Thursday; condition examinations.
Jan. 31.....Friday; registration.
Feb. 3.....Monday, 8:00 A. M.; second semester begins.
Feb. 22.....Saturday, Washington's Birthday recess.
March 14.....Friday, President's Day recess.
April 17.....Wednesday, 5:00 P. M.; Easter recess begins.
April 21.....Monday, 8:00 A. M.; classes resumed.
May 30.....Friday, Memorial Day recess.
May 28-29-31.....Wednesday, Thursday, Saturday; semester examinations.
May 29-31.....Thursday, Saturday; condition examinations.

INFORMATION.

For information concerning the College of Applied Science and Engineering address the Registrar, 1115 Grand Avenue. Interested persons are urged to call at the Registrar's office whenever possible, since personal interviews are much more satisfactory than correspondence.

REGISTRATION.

The office of the Registrar, first floor of the Administration building of Marquette University, 1115 Grand Avenue, is open for consultation daily, except Sunday, 9-12 A. M., 2-5 P. M.

Appointments will be made by the Registrar at hours agreeable to both parties, should the above hours be inconvenient.

Students are urged to register promptly at the specified time.

FOREWORD.

The College of Engineering is the natural outgrowth of the expansion of Marquette University. Its location is fortunate, in being situated in a large manufacturing center; many and varied engineering enterprises are constantly in progress; and the friendly relations between Marquette University and the different shops, factories, and transportation companies give the student advantages that are of great benefit to him in his future career.

There is a strong demand for trained engineers, especially in the Northwest, owing to the industrial activity of the region. To equip men to meet this demand is the object and purpose of the Engineering Department; this equipment demands not only a solid foundation of theory, but above all, thorough drill in the practical applications of theory, to fit the student to grapple with the new and difficult problems he will be likely to meet.

In drawing up the Courses of Study, careful comparison has been made of the courses, and of the actual experiences gained by members of the faculty, in other standard engineering schools. An engineer's training cannot be narrow, and for this reason great importance is attached to English; the relative value assigned to other branches at Marquette is in close accordance with the usage of the prominent Schools and Universities. Every attempt will be made to maintain a high level of study and efficiency, and there is no hesitation in dropping from the rolls students whose application to work is considered unsatisfactory.

OFFICERS.

REV. H. C. NOONAN, S. J. ..... *President*
REV. EUGENE RUDGE, S. J. ..... *Treasurer*
REV. JOHN B. KREMER, S. J. ..... *Faculty Regent*
J. C. PINNEY, C. E. ..... *Dean*
E. A. FISCHER, B. J. ..... *Registrar*

FACULTY.

REV. HERBERT C. NOONAN, S. J.,
Professor of Ethics.

J. C. PINNEY, C. E.,
Dean of the School of Engineering.
Professor of Civil Engineering.

REV. JOHN B. KREMER, S. J.,
Faculty Regent.
Director and Professor Department of Physics, Astronomy.

ROBERT N. BAUER, Ph.G., B.S.,
Director of Chemical Laboratories.
Professor of Chemistry.

WILLIAM D. BLISS, B.S., Ch.E.,
Professor of Mechanical Engineering.

REV. TERENCE H. DEVLIN, S. J.,
Professor of English.

REV. A. F. FRUMVELLER, S. J., Ph.D.,
Professor of Mathematics.

REV. JOHN P. McNICHOLS, S. J.,
Professor of English.

BERNARD A. ABRAMS,
Professor of Modern Languages.

REV. PAUL MUEHLMANN, S. J.,
Professor of Mathematics and Chemistry.

REV. AUGUSTINE D. THEISSEN, S. J.,
Assistant Professor of Mathematics.

GEORGE H. SCARCLIFF, B.S., C.E.,
Instructor of Civil Engineering.

JOS. E. L. FYANS, Ph.B., M.A.,
Instructor in Modern Languages.

WILLIAM WORTKOETTER, S. J.,
Assistant Professor of Physics and Geology.

GENERAL INFORMATION.

LOCATION.

Marquette University is located in Milwaukee, the commercial and social center of the state of Wisconsin and the great manufacturing center of America. The city is attractively situated on Lake Michigan, 85 miles north of Chicago. It is readily accessible from all points; ample railroad connections are afforded by the Chicago & Northwestern, the Chicago Milwaukee & St. Paul, the Soo Line, and three interurban lines. Also many points on Lake Michigan are in direct communication with Milwaukee by means of steamboat lines.

The advantages of Milwaukee are manifold:

Health: Is one of the most healthful cities in the United States. While the business section lies in a valley the elevations which surround it afford most delightful residence sections and excellent drainage. Deep water intakes extending far out into Lake Michigan afford a clear, cold and abundant supply of pure drinking water.

Homes: Is essentially a "city of homes." The percentage of those owning their own homes and maintaining lawns and gardens exceeds that of any other city of the Union. It has no congested or slum districts. The residence streets are especially beautiful, many being overarched with maple and elm trees.

Beautiful: One of the sights which is a source of surprise and delight to visitors, is the Milwaukee bay. It suggests the Bay of Naples and is viewed from Juneau Park, near the heart of the city. No city on the Great Lakes has succeeded in reserving so beautiful a spot for public convenience and pleasure.

Parks and Boulevards: The park system is the admiration of all visitors. Every section of the city has its own park. Park area: City, 922 acres; adjacent to city, 320 acres. Boulevards, 21,640 feet. There are five public natatoriums, two bathing beaches, and also public golf links in the city.

Resorts: Within fifty minutes' ride of the famous Waukesha Springs; within two hours' ride, hundreds of Wisconsin's most beautiful lakes and summer resorts. Trains and interurban cars at all hours.

Civic: One of the most orderly and law abiding cities in the nation, having a lower percentage of vice and crime than any other large city.

Education: The standard of its school system is the highest. It maintains besides Marquette University, a state normal school, several colleges, and is the first American city to maintain completely equipped trade schools as a part of the common school system.

Street Car Service: One hundred and one miles, most of it double track, within the one-fare limit. By a transfer system it is possible to ride twelve or more miles for a single fare, and one line carries many passengers nine miles without change of cars and a single fare.

Commercial and Industrial: The value of the year's production (1916) for fifteen leading industries was as follows:

Character.	Value of Products.
Iron, steel, heavy machinery	$61,633,613
Packed meat	37,100,000
Leather	36,000,000
Beer and malt tonics	26,235,438
Building	18,000,000
Coal and wood products	23,500,000
Boots and shoes	16,321,000
Malt	14,000,000
Electric and telephone supplies	20,100,000
Electric service	7,648,278
Agricultural implements	7,800,000
Hosiery	7,500,000
Distilled and rectified liquor	8,000,000
Cigars and tobacco	7,400,000
Auto accessories, commercial trucks	10,000,000

Followed by sixty-nine other important industries aggregating a total production of $463,287,999 last year.

It is safe to say that while Milwaukee is one of the largest industrial centers of the United States, it is also a city which produces a more diversified line of manufacture than any other. It draws its supply of raw materials in convenient proximity; secures its fuel by the Great Lakes water route at low rates; has ample transportation connections to ship its products to the four ends of the earth; enjoys a skillful, industrious and peaceful labor constituency.

As a commercial center it possesses some decided advantages. As the metropolis of the great state of Wisconsin, which holds a high place among the leading agricultural states of the Union, it has become an important distributing center for all commodities. Its jobbing and wholesale houses, which have grown into great commercial enterprises, have extended their trade connections far beyond the boundaries of the state.

Because of its location Marquette University offers unparalleled advantages to the student. He can gain an insight into the practical side of his future profession while still attending the classes.

EQUIPMENT.

Engineering Laboratory.

The laboratory equipment for Engineering includes:

One Riehle 50,000 lbs. universal testing engine; 1 wire testing apparatus, capacity 500 lbs.; 1 Beam testing machine, capacity 300 lbs.; 1 Riehle cement machine, capacity 1,000 lbs.; 1 12 x 24 Corliss engine; 1 high speed 10 x 10 automatic engine; 1 high speed 5½ x 7½ automatic engine; 1 double eccentric 5½ x 7½ marine engine; 1 10-H.P. horizontal gas engine; 1 42-H.P. Wisconsin automobile engine; 1 3-H.P. gas engine; 1 3-H.P. horizontal oil engine; 1 pumping station testing plant (4 x 6 x 8), Simple pump; 1 boiler injector testing rack; 1 testing rack for testing Indicator springs, thermometers, steam gauges, and flow of steam through nozzles; 1 water meter testing plant; 1 Crosby gauge tester; 3 5 x 16 high pressure return tubular

boilers; 24 x 12 Tire box boilers. (These furnish the heating plant of the adjacent University buildings.)

The testing apparatus mentioned above is employed in studying the physical properties of all building materials, metal and timber beams, etc., and includes all necessary auxiliary equipment. The 5 x 7 automatic engine and the double eccentric Marine engine arranged with water-cooled friction wheels, indicator piping, and exhaust to a condenser. The gasoline engine is belted to a generator and serves as a complete gasoline electric power plant; a Prony brake affords independent tests on the engine.

In the pump testing plant, any desired pressure is obtained by means of valves on the feed and discharge piping of the pump; the two graduated receiving tanks return the water to the reservoir tank.

The automobile plant is designed to receive automobiles of any type and power, and allows their operation to be studied while running under all road conditions; a specially designed dynamometer measures the tractive effort of the rear wheels.

The arrangement of the boilers is such as to permit tests on one or more without interruption to the action of the others. The 10 x 10-inch high speed automatic, and the Corliss engine are each belted to separate generators, and the piping arrangements permit each to be operated by any one of the boilers, thus providing two separate and distinct types of power plants; the load is obtained from a light line, or a water rheostat. Both engines have water-cooled friction wheels, and Prony brakes.

The Electrical Laboratory.

Electric equipment including: 1 50-K.W. Allis-Chalmers D. C. generator; 1 40-K.W. Northern Electric D. C. generator; 1 6-K.W. Allis-Chalmers D. C. generator; 1 21½-H.P. Westinghouse series motor; 1 15-H.P. Westinghouse shunt motor; 1 1-H.P. Crocker-Wheeler shunt motor; 1 5-H.P. Triumph rotary converter; 1 10-H. P. Westinghouse single phase motor; 1 1-H.P. Westinghouse single phase motor; 1 ½-H.P. General Electric D. C. motor; 1 1-H.P. Holtzer-Cabot D. C. motor; 2 5-K.W. lighting transformers; 2 40/5 amperes current transformers; 1 2,200-volt potential transformer; 1 10-ampere Murcury Arc rectifier; 1 60-K.W. water-cooled pipe rheostat for loading large generators; 1 apparatus for arc lamp photometry, and all instruments necessary for conducting efficiency and commercial tests and for determining operating characteristics on the above apparatus, including D. C. ammeters and voltmeters, A. C. ammeters, voltmeters, wattmeters and multipliers, rheostats, etc., are provided. The electrical plant furnishes light and power to the adjacent University buildings.

Chemical Laboratory.

The Chemistry lecture room and laboratories occupy the fourth floor of the Administration building.

The lecture room has a capacity of sixty students and is equipped with fume chamber for demonstrations, the lecture tables being supplied with necessary gas, water and electrical connections.

The laboratories have concrete floors throughout and are well lighted. They contain tables with locker equipment for one hundred and twenty-eight students, each locker being furnished with the necessary glassware; apparatus to replace that broken, or for special experiments, may be drawn from the stock room.

The tables are supplied with water and gas connections. Each table has connections to 110 V Direct and 110 V and 220 V alternate electric currents.

The balance room contains three Sartorius balances, and a sufficient number of others less sensitive to supply all wants.

The equipment for quantitative and applied analysis includes the necessary graduated glassware, electrodes and stands for electrolytical analysis; stills for analysis of water; Hempel's, Elliott's, and Orsat's gas pipettes, calorimeter, combustion furnaces, etc.

Physics Laboratory.

The Physics Department equipment occupies the third floor of the Arts and Science building. It comprises a commodious lecture hall, an office and library, and four laboratories. The lecture hall is provided with the usual facilities for experimental illustration. The laboratories are equipped with instruments of precision, such as cathetometer, micrometer microscope, chronograph, ballistic and Kater pendulums, air thermometer, spectroscope, interfermometer, as well as with all the apparatus required in the course of general physics of the Sophomores, and the advanced work of the Juniors. Elementary physics is taught in the Marquette Academy, the preparatory department of the University, and it is one of the required units for admission to the College of Engineering.

LIBRARY FACILITIES.

The magnificent public libarry of the city, almost adjoining the School of Dentistry and Pharmacy, is within two blocks of the Schools of Journalism, Arts and Sciences, Law, Economics, Engineering. The arrangement of the library is an ideal one for students, who have access to all the books for consultation and study, and may, with special privilege, take home with them as many books as are necessary for the preparation of essays, debates, etc. The main library and its eight branches contain 325,000 volumes.

The Science room has about 25,000 volumes. On different shelves are books on Natural Science, Mathematics, Physics, Electricity, Chemistry, Geology, Biology, Archeology, Paleontology, Botany, Zoology, Birds, Mammals, Engineering and Agriculture.

In the History room are more than 40,000 volumes, including 15,000 on Sociology, 7,177 on Travel, 11,087 on Biography, and 11,900 on History. The Philosophy room contains about 5,000 volumes.

The Literature room contains 38,000 volumes, among which are American, English, French, German, Grecian, Roman, Italian, Spanish, Portuguese literatures, also a goodly number of Swedish, Danish, Dutch, Flemish, Semitic and Slavic and many books of Japanese, Chinese and Celtic literatures.

The College Library contains nearly 13,000 volumes. Its circulating department, accessible to the members twice a week, comprises standard English works, carefully selected with a view to the needs of the College students.

The library of the School of Applied Science and Engineering contains the latest volumes of all leading periodicals. The bond reports of the A. S. M. E. and many Engineering texts are available.

MUSEUM.

The Museum of the city of Milwaukee is within three minutes' walk of the University. The collection is one of the largest and finest in the United States, and contains hundreds of thousands of zoological, botanical, minerological and other specimens.

ENTRANCE REQUIREMENTS.

1. ADMISSION.

All applicants for admission must present evidence of good moral character and, if they come from another college, a certificate of honorable dismissal.

Admission by Certificate. A certificate from the principal of an accredited high school in which a student has been prepared for college will be accepted instead of examinations in the subjects offered for admission.

2. REQUIREMENTS FOR ADMISSION.

All candidates for a degree must present entrance credits amounting to the number of units specified in the course selected. A unit represents a year's study in a high school subject pursued four or five times a week.

3. SUBJECTS ACCEPTED FOR ADMISSION.

Latin.

(1) Grammar.—The entire Latin Grammar, including a knowledge of all regular syntactical constructions; translations into Latin, at sight, of complex English sentences, entailing the application of rules for relative clauses, indirect discourse and conditional sentences.

(2) Composition.—Translation into Latin of easy continuous prose, based on Caesar's Gallic War and on the Letters and Orations of Cicero.

(3) Authors.—Caesar: De Bello Gallico, four books. Ovid: Metamorphoses and Tristia. Cicero: The Orations against Catiline. Virgil: Aeneid, six books.

Greek.

(1) Grammar.—Etymology complete (including the irregular and defective forms); the rules of accents; syntax; the Homeric dialect.

(2) Composition.—Translation into Greek of simple English sentences based on Xenophon's Anabasis.

(3) Authors.—Xenophone; Anabasis, four books. Homer: Iliad, three books, or Odyssey, three books.

English—Rhetoric.

The candidate must be prepared on the matter contained in a standard text-book such as Hill, Coppens, Williams, Genung, Carpenter, Thorndike, Brooks.

Composition.—A brief prose composition will be required, evidencing proficiency in the writing of clear, idiomatic English. The subject will be taken from the candidates' experience, or based on the books he presents for examination.

Fair penmanship and accurate spelling will be considered as essential preliminary requirements.

English.

Texts prescribed for reading and study: Two plays of Shakespeare; Burke's Conciliation with the Colonies, or American Taxation; Irving's Sketch Book; one essay of Macaulay; Scott's Lady of the Lake; Goldsmith's Deserted Village; Tennyson's The Passing of Arthur; Lowell's Vision of Sir Launfal; Coleridge's Ancient Mariner.

The applicant should make himself familiar with the characters, the plot, incidents and characteristic diction of each work. Equivalents will be accepted.

French, German, Spanish.

1. Elementary grammer, easy prose and themes.
2. Syntax, moods, complex sentences, easy prose writing.
3. Good reading knowledge of standard prose, with syntax.
4. Acquaintance with classics and lyric poets.
   The texts this year at Marquette are Chardenal (French) and Becker (German). Equivalent text-books must be used by students.

Spanish.

(Same as for first two years of German and French.)

History.

(1) Ancient History, including the history of the Oriental nations, Greece and Rome.

(2) Modern History from the foundation of the Holy Roman Empire to the present time.

(3) United States History and Civics.

History and Civics.

1. United States, or English History.
2. Ancient History.
3. European History.

   Civics counts as ½ unit and may be combined with History.

Elementary Sciences.

The requirements are those of the standard High School texts, such as "McPherson and Henderson" (in Chemistry); "Martin" (in Physiology); "Linville and Kelly" or "Jordan and Kellogg" (in Zoology); "Atkinson" or "Bergen" (in Botany); "Milliken and Gale" or "Mann and Twiss" or "Carhart and Chute" (in Physics) "Davis" or "Tarr" (in Physical Geography); "Howe" or "Todd" or "Young" (in Astronomy); "Norton" or "Tarr" (in

Geology). Work in Biology (e. g., "Bailey & Coleman") may be offered as ½ units in Zoology and ½ unit in Botany. All notes, note books, laboratory work, etc., in the above subjects, must be presented, especially in Physics, Chemistry and Geology, where they are absolutely required as essential to a proper course.

Algebra.

Fundamental operations, factoring, fractions, linear equations, radicals and exponents, quadratics, graphs, and problems involving all these are required; additional work in logarithms, elementary series, simultaneous quadratics, ratio and variations, binomial theorem, may be offered as ½ unit.

Trigonometry.

The six functions, and their relations, addition theorems, simpler transformations, and the solution of plane triangles, right and oblique.

Geometry.

Any standard text; original demonstrations, loci, and numerical work are of great importance.

Vocational Subjects

Such as Drawing, Commercial Law, Commercial Geography, Bookkeeping and Manual Training, are accepted with reluctance. A student offering such credits must furnish a comprehensive and full account of these studies and of the number of recitation or class hours spent in them, together with specimens of work done. Tests may be exacted if any doubt remains; and in no case will the total credits in this group be more than 2.

Admission may likewise be had by transfer from another recognized college or university, on presentation of an official statement of the student's standing, and a certificate of honorable dismissal.

Applicants, not graduates of an accredited high school or transferred in good standing from an institution of equal rank, are subject to entrance examinations, which are held in September and June. Detailed information as to the hour and place of such examinations will be furnished to applicants at the Registrar's office.

Special students, not candidates for a degree, may be admitted to certain courses, provided they are over 19 years of age, and show the ability to pursue their studies with profit. The credit to be assigned for such work will be determined upon by the Dean of the department.

UNITS REQUIRED FOR ADMISSION.

The following units are required of all degree students:

Elementary Algebra	1½ units	English Literature	1 unit
Plane Geometry	1 unit	History	1 unit
Solid Geometry	½ unit	Elementary Physics	1 unit
English Composition	1 unit	Electives	7 units

ELECTIVE UNITS.

The elective subjects that may be presented to complete the required units must be taken from the following list:

English	1 to 2 units
Spanish, French, German	1 or 2 units
Latin, Greek	1 to 2 units
History (not more than four units in all):	
Ancient History	1 unit
Medieval and Modern History	1 unit
English History	1 unit
United States History	1 unit
Science (not more than four units in all):	
Biology	1 unit
Botany	1 unit
Chemistry	1 unit
Physics	1 unit
Physical Geography and Geology	1 unit
Zoology	1 unit
Physiology	½ unit
Algebra (intermediate)	½ unit
Trigonometry	½ unit
Agriculture	1 unit
Drawing	1 unit
Vocational subjects and Manual Training	2 units
Music:	
Appreciation or Harmony	1 unit

Limitations.—Not more than four units will be accepted in any one subject. Students desiring credit in a foreign language must have at least two units in the subject. One unit of credit for a second foreign language will be given if the student has at least three units in the first language.

No Collegiate Credit is Given for High School Work.

SPECIALS.

The requirements as a special student will not be as rigid as for regular students, but will be governed in each case by the judgment of the Dean and faculty, concerning the applicant's fitness profitably to pursue the particular subject or subjects he may wish to follow.

Every applicant must present to the Dean a detailed and certified statement of his previous studies.

ADVANCED STANDING.

Due credit will be allowed for advanced work done at other Universities and Colleges of accepted standing, when work is closely similar to courses given in this school. Application for advanced standing may be made personally or in writing and should be accompanied by a detailed statement from the proper authority of the nature of the work for which credit is asked.

TUITION AND FEES.

No student will be admitted to classes before the fees for the current semester have been paid. No exception will be made and students should come prepared. Tuition and fees once paid cannot under any circumstances be returned. A student who leaves the University for valid reasons during the year will be allowed a credit for the unpaid tuition provided that he pursues his departmental studies within one year from the date of his withdrawal. Tickets cannot be transferred. Students make an implicit contract with the institution to observe these conditions when they pay their dues.

An annual athletic fee of $5.00 will be charged each student, which admits him to all local games played under the auspices of the Athletic Association. It must be paid at the time of matriculation or at the opening of the Fall session.

A fee of $1.00 per examination, payable in advance to the Registrar, will be charged each student for whom it is necessary, for any reason whatsoever, to give make-up or condition examinations or special examinations. The fee for a "condition" examination on any other but the date set, will be $2.00.

The matriculation fee of Freshmen and new students is distinct from the tuition and must be paid when the student decides to enter the University.

Tuition for the Academic year	$125.00
First Semester	75.00
Second Semester	50.00
Matriculation	5.00
Athletic fee	5.00
Chemistry fee (per year, plus breakage)	1.00
Lake Beulah (once for civil engineering)	20.00

Payments for tuition, etc., must be made in two installments, on October 1st, and February 1st. A student who leaves this college for valid reasons during the year, may redeem the unpaid tuition by pursuing his departmental studies within one year from the date of his withdrawal.

SUMMER COURSES

are likewise offered at Marquette University (in July and August). They afford an opportunity to conditioned or prospective students for making up their deficiencies. A separate "Bulletin of Summer Courses" can be had from the Registrar's office.

SPECIAL LECTURES

by engineers, faculty members and invited guests are given to the engineering students at intervals during the year; many of these lectures are illustrated.

REGULATIONS.

A regular student, candidate for a degree, must pursue at least 14 credit hours of work prescribed for the year in which he registers. A credit hour is interpreted as meaning one hour per week for one semester in recitation or lecture, or two hours per week for one semester in laboratory, field, or drawing room.

A special student will be allowed to take such subjects as his previous training will permit, or as the Dean of the College of Engineering may prescribe.

A final average in any subject of 67% or over entitles the student to a passing grade in that subject. A final average below 67% and above 59% entitles the student to a condition in that subject. A final average of 59% or lower in any subject is considered as failure in that subject and the student must repeat the subject.

A condition can be removed by a special examination or by the completion of a special assignment by the professor in charge. Conditions must be removed by the beginning of the second semester following the one during which the condition was incurred.

A student who has failed to complete his assignments during a semester will be credited with an "incomplete" for the semester's work in that subject, and such incomplete must be removed to the satisfaction of the professor in charge during the following semester. If not removed within that time, the student will be required to repeat the subject.

Students are required to attend classes regularly. Continued absence will be deemed sufficient reason for dropping the student from the class. Except when the student has a valid and acceptable excuse, absence from a class period will give him a grade of zero for the day's work in that subject, and he will not be given an opportunity to make up the lost work. Under no considerations will an opportunity be given to make up absences from quizzes.

A student who has been registered in a subject will under no considerations be allowed to drop that subject unless he has the written consent of the Dean.

Special examinations for the removal of conditions will be given at such times as are stated in the calendar. A charge of $1.00, payable in advance, will be made for all such special examinations.

Students desiring special consideration or exemption from any of the above rules must present their requests in writing with reasons therefor to the Dean.

Improper or ungentlemanly conduct, dishonesty, or continued carelessness or neglect of work, will be considered sufficient reason for terminating a student's connection with this institution.

DEGREES.

The degree of Bachelor of Sciences in Civil, Mechanical or Electrical Engineering, is conferred on those who have successfully completed the work outlined in the following courses of study. A thesis embodying original work is an integral part of the student's qualifications for this degree. The professional degrees of Civil Engineer, Mechanical Engineer, Electrical Engineer, are conferred on graduates of the Engineering College of Marquette University, who during three years subsequent to graduation have proven their standing and ability by professional work or by original research, contributions to scientific journals, or professional work. The applicant for a professional degree must present to the Dean of the Engineering Department during the month of October, a statement of his work and experience, and announce the subject of his thesis. An outline of the thesis must be submitted for approval, and the completed thesis must be in the hands of the faculty by April 1st.

Graduate study in this University, or any other of equal rank, may be accepted as part of the requirements for a professional degree. No other degrees are at present conferred in the Engineering Department, besides those specified above.

SCHEDULE OF COURSES.

FRESHMAN YEAR.

The course for the Freshman year is the same for all students.

FIRST SEMESTER.		CREDIT.
Mathematics 5	Advanced Algebra	5
Chemistry 2	General Chemistry	4
Drawing 1	Elementary Drawing	3
English 1	Rhetoric and Themes	3
Civil Eng. 1	Plane Surveying	2

SECOND SEMESTER.		CRDEIT.
Mathematics 6	Trigonometry and Analytic Geometry	5
Chemistry 3	Qualitative Analysis	4
Drawing 2	Elementary Drawing	3
English 2	Rhetoric and Themes	3
Civil Eng. 2	Elementary Surveying	2

CIVIL ENGINEERING.

SOPHOMORE YEAR.

FIRST SEMESTER.		CREDIT.
Mathematics 7	Differential Calculus	4
Chemistry 5	Quantitative Analysis	3
Physics 2	Mechanics, Molecular Physics and Heat,	4
Physics 102	Physics Measurements	1
Civil Eng. 3	Advanced Surveying	4
Civil Eng. 21	Railroad Curves	2

SECOND SEMESTER.		CREDIT.
Mathematics 8	Integral Calculus	4
Physics 3	Electricity, Heat, Light	4
Physics 103	Physical Measurements	1
Mechanics 1 and 3	Statics—Mechanics of Materials	5
Drawing 3	Descriptive Geometry	3
Civil Eng. 3	Advanced Surveying	3

JUNIOR YEAR.

FIRST SEMESTER.		CREDIT.
Mechanics 4 and 2	Mechanics of Materials—Dynamics	5
Mechanics 6	Testing Materials	2
Mech. Eng. 16	Engines and Boilers	2
English 3e	Technical English	3
Civil Eng. 22	Railway Location and Construction	3
Civil Eng. 41	Theory of Structures	4

SECOND SEMESTER.		CREDIT
Mechanics 5	Hydraulics	4
Mechanics 7	Testing Materials	2
Mech. Eng. 23	Mechanical Laboratory	2
English 4e	Technical Writing	3
Civil Eng. 23	Railway Location and Construction	3
Civil Eng. 61	Masonry Construction	2
Civil Eng. 71	Highway Engineering	3

SENIOR YEAR.

FIRST SEMESTER.		CREDIT.
Electr. Eng. 6	Direct Currents	2
Electr. Eng. 24	Testing Electrical Machinery	1
Civil Eng. 42	Structural Design	4
Civil Eng. 49	Reinforced Concrete Design	2
Civil Eng. 47	Principles of Reinforced Concrete	2
Civil Eng. 62	Foundations	1
Civil Eng. 101	Water Supplies	3
Electives		4

SECOND SEMESTER.		CREDIT.
Electr. Eng. 7	Alternating Currents	2
Electr. Eng. 25	Testing Electrical Machinery	1
General Eng. 1	Contracts and Specifications	2
General Eng. 2	Cost Analysis	2
Civil Eng. 43	Bridge Design	4
Civil Eng. 48	Principles of Reinforced Concrete	2
Civil Eng. 50	Reinforced Concrete Design	2
Electives		4

ELECTRICAL ENGINEERING.

SOPHOMORE YEAR.

FIRST SEMESTER.		CREDIT.
Mathematics 7	Differential Calculus	4
Chemistry 5	Quantitative Analysis	3
Physics 2	Mechanics, Molecular Physics and Heat,	4
Physics 102	Physical Measurements	1
Mech. Eng. 1	Mechanism	4
Mech. Eng. 30	Metallurgy	2

SECOND SEMESTER.		CREDIT.
Mathematics 8	Integral Calculus	4
Physics 3	Electricity, Heat, Light	4
Physics 103	Physical Measurements	1
Chemistry 108	Fuel and Gas Analysis	2
Drawing 3	Descriptive Geometry	3
Mechanics 1 and 3	Statics and Mechanics of Materials	5

JUNIOR YEAR.

FIRST SEMESTER.		CREDIT.
Mechanics 4 and 2	Mechanics of Materials—Dynamics	5
Physics 107	Electric Measurements	2
English 3e	Technical English	3
Mech. Eng. 10	Thermodynamics	5
Mech. Eng. 20	Mechanical Laboratory	1
Electr. Eng. 1	Direct Currents	3

SECOND SEMESTER.		CREDIT.
Mechanics 5	Hydraulics	4
English 4e	Technical Writing	3
Mech. Eng. 11	Thermodynamics	2
Mech. Eng. 21	Mechanical Laboratory	2

SECOND SEMESTER.		CREDIT.
Electr. Eng. 2	Direct Currents	2
Electr. Eng. 3	Alternating Currents	3
Electr. Eng. 21	Electrical Laboratory	2

SENIOR YEAR.

FIRST SEMESTER.		CREDIT.
Mechanics 6	Testing Materials	2
Economics		3
Mech. Eng. 22	Mechanical Laboratory	2
Civil Eng. 44	Structural Design	2
Electr. Eng. 4	Alternating Currents	3
Electr. Eng. 31	Electrical Design	3
Electr. Eng. 22	Electrical Laboratory	2
Electives		2

SECOND SEMESTER.		CREDIT.
Mechanics 7	Testing Materials	2
Gen. Eng. 1	Contracts and Specifications	2
Gen. Eng. 2	Cost Analysis	2
Electr. Eng. 5	Alternating Currents	3
Electr. Eng. 32	Electrical Design	3
Elec. Eng. 23 or 10	Electrical Laboratory or Power Distribution	2
Electives		5

MECHANICAL ENGINEERING

SOPHOMORE YEAR.

FIRST SEMESTER.		CREDIT.
Mathematics 7	Differential Calculus	4
Chemistry 5	Quantitative Analysis	3
Physics 2	Mechanics, Molecular Physics, and Heat,	4
Physics 102	Physical Measurements	1
Mech. Eng. 1	Mechanism	4
Mech. Eng. 41	Metallurgy	2

SECOND SEMESTER.		CREDIT.
Mathematics 8	Integral Calculus	4
Physics 3	Electricity, Heat, and Light	4
Physics 103	Physical Measurements	1
Chemistry 108	Fuel and Gas Analysis	2
Drawing 3	Descriptive Geometry	3
Mechanics 1 and 3	Statics and Mechanics of Materials	5

JUNIOR YEAR.

FIRST SEMESTER.		CREDIT.
Mechanics 4 and 2	Mechanics of Materials and Dynamics	5
Chemistry 110	Iron and Steel Analysis	2
English 3e	Technical English	3
Electr. Eng. 1	Direct Currents	3
Mech. Eng. 10	Thermodynamics	5
Mech. Eng. 20	Mechanical Laboratory	1

SECOND SEMESTER.		CREDIT.
Mechanics 5	Hydraulics	4
English 4e	Technical Writing	3
Electr. Eng. 3	Alternating Currents	3
Electr. Eng. 21	Electrical Laboratory	2
Mech. Eng. 11	Thermodynamics	2
Mech. Eng. 21	Mechanical Laboratory	2
Mech. Eng. 2	Machine Design	3

SENIOR YEAR.

FIRST SEMESTER.		CREDIT.
Mechanics 6	Testing Materials	2
Economics		3
Civil Eng. 44	Structural Design	2
Electr. Eng. 4	Alternating Currents	3
Electr. Eng. 22	Electrical Laboratory	2
Mech. Eng. 12	Gas Engines	2
Mech. Eng. 3	Machine Design	3
Mech. Eng. 22	Mechanical Laboratory	2

SECOND SEMESTER.		CREDIT.
Mechanics 7	Testing Materials	2
Gen. Eng. 1	Contracts and Specifications	2
Gen. Eng. 2	Cost Analysis	2
Mech. Eng. 13, 14	Steam Turbines and Air Compressors	2
Mech. Eng. 4	Machine Design	2
Mech. Eng. 42	Metalography	2
Mech. Eng. 43	Heat Treatment of Iron and Steel	2
Electives		5

CIVIL ENGINEERING COURSES.

TOPOGRAPHICAL GROUP.

COURSE 1.—***Elementary Surveying.*** I; (2).* *Four hours in field first half of semester. One lecture per week throughout the semester.* The course consists of a study of the principles and practice of chaining and leveling. A strict standard is enforced in the form of the student's field records and notes.

COURSE 2.—***Elementary Surveying.*** II; (2). *Four hours per week in field last half of semester. Must be preceded by Course* 1. *One lecture per week throughout the semester.* This is a continuation of Course 1. It includes a further study of the principles and uses of the level and its adjustments, and a preliminary study of the transit with a few simple problems in its use.

COURSE 3.—***Advanced Surveying.*** I; (4). *Four hours per week of field and drafting throughout the semester. Two recitations per week throughout the semester. Must be preceded by Course* 2. This course consists of a study of the principles and uses of the transit and the principles of land, city, and topographic surveying. Field problems consist of the practical application of the theory taught in the class room, and the field notes are reduced and platted in the drafting room.

COURSE 4.—***Advanced Surveying.*** II; (3). *Two recitations throughout semester. Four hours field work last half of semester. Must be preceded by Course* 3. This is a continuation of Course 3 and includes stadia measurements, and the use of the Solar Attachment.

RAILWAY GROUP.

COURSE 21.—***Railway Curves.*** I; (2). *Two class hours per week throughout the semester. Must be preceded by Course* 2 *and Math.* This course consists of a study of the theory and location of the simple, compound, reverse, and spiral curve and railway turnouts.

COURSE 22.—***Railway Location and Construction.*** I; (3). *Two class hours per week throughout the semester. Four hours in field first half of semester. Must be preceded by Courses* 3 *and* 21. The theory of field and office work necessary to locate and construct a new railway line and to improve or reconstruct an old one.

COURSE 23.—***Railway Location and Construction.*** II; (3). *Two class hours per week throughout the semester. Four hours in field last half of semester. Must be preceded by Course* 22. This is a continuation of Course 22 and includes the study of problems in earthwork, also some work in the economics of railway location, train resistance, etc.

COURSE 24.—***Railway Design.*** (2). *Four hours drafting throughout the semester. Must be preceded by Course* 21. This is a course in the design of frogs, switches and yard layouts.

STRUCTURAL GROUP.

COURSE 41.—***Theory of Structures.*** I; (4). *Four class hours per*

*The Roman numerals I and II, indicate respective semesters. The Arabic numerals in parenthesis indicate the number of hours of recitation weekly.

week throughout the semester. Must be preceded by Mechanics 3 *and accompanied by Mech.* 4. This course consists of the determination by both analytical and graphical methods the stresses in the various types of roof and bridge trusses.

COURSE 42.—***Structural Design.*** I; (4). *Eight hours per week in the drafting room. Must be preceded by Course* 41. In this course each student is gven a different set of conditions under which he designs completely wooden and steel roof trusses and a railroad plate girder bridge.

COURSE 43.—***Bridge Design.*** II; (4). *Eight hours per week in drafting room. Must be preceded by Course* 42. This course consists of the complete design by each student of a pin connected railroad bridge.

COURSE 44.—***Structural Design.*** I; (2). *Four hours per week in drafting room. Must be preceded by Mechanics* 3 *and accompanied by Mech.* 4. A course in the design of steel buildings especially arranged for Mechanical and Electrical Engineering students.

COURSE 45.—***Bridge Engineering.*** I; (2). *Two class hours per week. Must be preceded by Course* 41, *"Theory of Structures."* This course takes up stresses in statically indeterminate structures as well as the deflection of structures and the determination of the true stresses in redundant members. Both graphic and analytic methods are used.

COURSE 46.—***Advanced Bridge Design.*** II; (2). *Four hours per week in drafting room. Must be preceded by Course* 45, *"Bridge Engineering."* This course consists of the design of a swing bridge.

COURSE 47.—***Principles of Reinforced Concrete.*** I; (2). *Two class hours per week. Must be preceded by Course* 41 *and Mechanics* 6 *and* 7. The theory of structures as applied to reinforced concrete design. Analysis and problems in design and construction.

COURSE 48.—***Principles of Reinforced Concrete.*** II; (2). *Two class hours per week. Must be preceded by Course* 47. This is a continuation of Course 47.

COURSE 49.—***Reinforced Concrete Design.*** I; (2). *Four hours per week in drafting room. Must be accompanied by Course* 47. The principles of reinforced concrete as applied to building design.

COURSE 50.—***Reinforced Concrete Design.*** II; (2). *Four hours per week in drafting room. Must be preceded by Course* 49 *and accompanied by Co..rse* 48. A continuation of Course 49 in which the various types of reinforced concrete construction are considered.

COURSE 51.—***Concrete Arches.*** II; (2). *Four hours per week in drafting room. Must be preceded by Course* 45. This course consists of a series of lectures and design periods. The lectures apply the principles of statically indeterminate structures to concrete arches. The actual design of a concrete arch is made.

COURSE 61.—***Masonry Construction.*** II; (2). *Two class hours per week. Must be preceded by Mechanics* 4. A study of the principles and design of various types of masonry.

COURSE 62.—***Foundations.*** I; (1). *One class hour per week. Must be preceded by Mechanics* 4. A study of the principles and design of various types of foundations.

HIGHWAY GROUP.

COURSE 71.—***Highway Engineering.*** II; (3). *Three class hours per week.* A study of the principles of street construction and design. Various types are taken up.

SANITARY AND HYDRAULIC GROUP.

COURSE 101.—***Water Supply Engineering.*** I; (3). *Three class hours per week. Must be preceded by Mechanics* 5. A study of the general principles involved in the problems of municipal water supplies such as sources of supply, pumping, distribution, purification, etc.

COURSE 102.—***Sewerage and Irrigation.*** I, II; (2). *Two class hours per week. Must be preceded by Mechanics* 5. This course consists of a study of the principles involved in the design of a sewerage system and treatment works and of the principles involved in the design of irrigation and drainage systems.

COURSE 103.—***Water Power Engineering.*** I, II; (2). *Two class hours per week. Must be preceded by Mechanics* 5. A study of the principles involved in the consideration of a water power project such as the effects of variation of flow, head, etc., types, characteristics, selection, and installation of water wheels.

ELECTRICAL ENGINEERING COURSES.

COURSE 1.—***Direct Currents.*** I; (3). *Three class hours per week. Must be preceded by Mathematics* 8 *and Physics* 3. This course is a study of the fundamental principles direct current generation and use, magnetism, laws of electric and magnetic circuits, construction of direct current machinery, etc.

COURSE 2.—***Direct Currents.*** II; (2). *Two class hours per week. Must be preceded by Course* 1. This is a continuation of Course 1 in which a more detailed analysis is made of the various types of machinery.

COURSE 3.—***Alternating Currents.*** II; (3). *Three class hours per week. Must be preceded by Course* 1. This course takes up the graphical and analytical method of dealing with electro-motive forces and currents in alternating current circuits, effects of resistance, inductance, capacity, etc.

COURSE 4.—***Alternating Currents.*** I; (3). *Three class hours per week. Must be preceded by Courses* 3 *and* 20. This is a continuation of Course 3 in which a study is made of the various types alternating current machinery such as generators, motors, transformers, etc.

COURSE 5.—***Alternating Currents.*** II; (3). *Three class hours per week. Must be preceded by Course* 4. A more complete study of the various types of alternating current machinery and controllers, including a more complete study of the method of complex imaginaries and their application to the more difficult electrical problems, investigation of wave distortion, etc.

COURSE 6.—***Direct Currents.*** I; (2). *Two class hours per week. Must be preceded by Mathematics* 8 *and Physics* 3. This is a course designed for Civil Engineering students to give them a clear idea of the general principles of direct current machinery.

COURSE 7.—***Alternating Currents.*** II; (2). *Two class hours per week. Must be preceded by Course* 6. This is a continuation of Course 6 in which the subject of alternating currents is considered.

COURSE 8.—***Electric Railways.*** I; (2). *Two class hours per week. Must be preceded by Course* 2. This is an elective course for Seniors and takes up the more important problems of electric railways.

COURSE 9.—***Illumination.*** II; (2). *Two class hours per week. Must be preceded by Course* 2. A study of the principles of commercial illumination, its relations to architecture, design of lighting installations, wiring, etc.

COURSE 10.—***Power Distribution.*** II; (2). *Two class hours per week. Must be preceded by Course* 3. Investigation of the various systems of distributing power electrically. Detailed study of the design of such systems including the choice of a system for a particular condition.

COURSE 21.—***Electrical Laboratory.*** II; (2). *Four hours per week in laboratory. Must be preceded by Course* 1. Testing of direct current machinery.

COURSE 22.—***Electrical Laboratory.*** I; (2). *Four hours per week in laboratory. Must be preceded by Course* 21. Testing of alternate current machinery.

COURSE 23.—***Electrical Laboratory.*** II; (2). *Four hours per week in laboratory. Must be preceded by Course* 22. A continuation of Course 22.

COURSE 24.—***Electrical Laboratory.*** I; (1). *Two hours per week in laboratory. Must be accompanied by Course* 6. This is a laboratory course designed for Civil Engineering students.

COURSE 25.—***Electrical Laboratory.*** II; (1). *Two hours per week in laboratory. Must be preceded by Course* 24. Continuation of Course 24.

COURSE 41.—***Electrical Design.*** I; (3). *Six hours per week in drafting room. Must be preceded by Course* 3. This course consists of the detailed design of some standard piece of electrical apparatus.

COURSE 42.—***Electrical Design.*** II; (3). *Six hours per week in drafting room. Must be preceded by Course* 41. This is a continuation of Course 41 in which alternating current machinery is taken up.

GENERAL ENGINEERING.

COURSE 1.—***Contracts and Specifications.*** II; (2). *Two lectures per week.* A study of the importance and requirements of engineering contracts and specifications.

COURSE 2.—***Cost Analysis.*** II; (2). *Two lectures per week.* A course in analyzing the costs of engineering works and their proper division into fixed and operating charges. The proper methods of determining the

most economical of two or more alternative projects is considered and a brief study of the methods of cost accounting.

MECHANICS.

COURSE 1.—***Statics.*** II or I; (2). *Five class hours per week firzt part of semester. Must be preceded by Physics* 2 *and accompanied by Mathematics* 8. Resolution and composition of forces, couples, center of gravity, cords and pulleys.

COURSE 2.—***Dynamics.*** I or II; (2). *Five class hours per week last part of semester. Must be preceded by Mechanics* 1. The laws of moving bodies, translation, rotation, friction, belts, work and energy.

COURSE 3.—***Mechanics of Materials.*** I or II; (3). *Five class hours per week last part of semester. Must be preceded by Course* 1. Application of the laws of statics to the various materials used in engineering structures.

COURSE 4.—***Mechanics of Materials.*** I or II; (3). *Five class hours per week first part of semester. Must be preceded by Course* 3. A continuation of Course 3.

COURSE 5.—***Hydraulics.*** II; (4). *Four class hours per week. Must be preceded by Course* 2. A study of the elementary principles of the mechanics of fluids, fluid pressures on rigid bodies, laws of flowing water and methods of measuring same.

COURSE 6.—***Testing of Materials.*** I; (2). *Must be preceded by Course* 3. A combination of lectures and laboratory periods dealing with the manufacture and testing of materials used in engineering structures.

COURSE 7.—***Testing of Materials.*** II; (2). *Four hours per week in laboratory. Must be preceded by Course* 6. This is a continuation of Course 6 in which the student performs individual tests of the various engineering materials.

MECHANICAL ENGINEERING COURSES.

MACHINE DESIGN GROUP.

COURSE 1.—***Mechanism.*** I; (4). *Two class hours per week. Four hours per week in drafting room. Must be preceded by Mathematics* 7 *and Drawing* 2. A systematic study is made of velocity diagrams and of the various forms of motion occurring in machines. A considerable part of the time is devoted to the design of cams and gears.

COURSE 2.—***Machine Design.*** II; (3). *Six hours per week in drafting room. Must be preceded by Course* 1 and *Mechanics* 2 *and* 4. This is a continuation of Course 1 with the application of mechanics necessary for determining the strength of machine parts. Each student is required to complete the design of some simple machine.

COURSE 3.—***Steam and Gas Engine Design.*** I; (3). *Six hours per week in drafting room. Must be preceded by Courses* 2, 10 *and* 11. This is essentially a course in design supplemented with lectures on the methods employed in determining the more important details of steam and gas engines.

Problems are assigned requiring the application of thermodynamic principles as well as the use of emperical formulae.

COURSE 4.—***Advanced Machine Design.*** II; (2). *Four hours per week in drafting room. Must be preceded by Course* 3. Lectures and drafting room work, dealing with the study of inertia forces that arise in various kinds of machinery, especially where high speeds are employed, and the methods of balancing these forces. This includes investigation of governors, dynamo armatures, centrifugal machines, the gyroscope and its applications, and the balancing of multicylinder engines.

STEAM AND GAS ENGINEERING GROUP.

COURSE 10.—***Applied Thermodynamics.*** I; (5). *Five class hours per week. Must be preceded by Mechanics* 1, *Physics* 3, *Chemistry* 2. This course embraces a detailed study of the elementary principles of thermodynamics, properties of steam, calorimeters, steam pumps, stokers and furnaces, feed-water heaters, superheaters, fuels and combustion.

COURSE 11.—***Applied Thermodynamics.*** II; (2). *Two class hours per week. Must be preceded by Course* 10. A continuation of Course 10 including a study of the principles underlying the simple and multiple expansion steam engine, the Carnot and Rankine Cycles, the indicator diagram, and various governing devices for reciprocating engines.

COURSE 12.—***Gas Engines.*** I; (2). *Two class hours per week. Must be preceded by Course* 11. A study of the internal combustion engine based on theory and practice. The various types of engines are studied with particular attention to the fuels used, carbureting, ignition, governing, lubrication, timing of valves, and general operating conditions. The course includes a study of recent developments in the design of Diesel and other engines.

COURSE 13.—***Steam Turbines.*** II; (1). *Two class hours per week first half of semester. Must be preceded by Course* 11. The thermodynamic principles underlying the design of steam turbines and discussion of the various types, their adaptability for different classes of service, and a comparison with the reciprocating engine.

COURSE 14.—***Compressed Air.*** II; (1). *Two class hours per week last half of semester. Must be preceded by Course* 11. A mathematical treatment of the problems entering into the production transmission, and application of compressed air. A study is made of the air compressor with particular reference to the effect of clearance, methods of cooling, advantages of compounding, etc. Attention is given to the hydraulic compressor, measurement of air, friction of air in pipes, and the air lift.

COURSE 15.—***Refrigeration.*** II; (1). *Two class hours per week last half of semester. Must be preceded by Course* 11. This course is designed to give the student a working knowledge of the problems entering into the selection of a mechanical refrigeration plant and includes a complete description of the various types of commercial ice machines and systems of refrigeration.

COURSE 16.—***Engines and Boilers.*** I; (2). *Two class hours per week. Must be preceded by Physics* 3, *Mathematics* 8. An abridged course

for civil engineers consisting of lectures and recitations on the operating principles of steam engines, boilers, and steam power plant auxiliaries.

COURSE 20.—***Mechanical Laboratory.*** I; (1). *Two hours per week in laboratory. Must be preceded by Mechanics* 1, *Physics* 3, *Chemistry* 2. This course runs parallel with Course 10. It includes the calibration of pressure gauges, thermometers, meters, etc., practice in the use of the steam engine indicator. It is intended to familiarize the student with mechanical laboratory instruments.

COURSE 21.—***Mechanical Laboratory.*** II; (2). *Four hours per week in laboratory. Must be preceded by Course* 20. This is a continuation of Course 20 including steam calorimeter tests, analysis of flue gases, flow of steam through orifices, steam engine valve setting, and mechanical efficiency tests of steam and gas engines.

COURSE 22.—***Mechanical Laboratory.*** I; (2). *Four hours per week in laboratory. Must be preceded by Course* 12. Evaporative tests of boilers, steam consumption, and power development of an electrical plant, tests of air compressors, steam pumps and injectors, the determination of efficiencies, losses, and characteristics of gas and oil engines.

COURSE 23.—***Mechanical Laboratory.*** II; (2). *Four hours per week in laboratory. Must be preceded by Course* 16. A special course for civil engineers which includes the operation of steam and gas engines and commercial methods of testing engines and boilers.

COURSE 30.—***Heating and Ventilating.*** (2). *One class hour per week. Two hours per week in drafting room.* Direct and indirect steam and hot water heating, gravity systems, vacuum systems, direct air heating, ventilating, temperature and humidity control, heating boilers and furnaces. The course includes a complete layout of a heating and ventilating system for a typical building.

COURSE 31.—***Power Plant Design.*** (2 or more.) *Drafting room supplemented with lectures.* This course includes a discussion of the mechanical problems involved in the selection of power plant units, including auxiliary equipment. Each student is required to select and arrange a complete plant equipment.

METALLURGICAL GROUP.

COURSE 41.—***Metallurgy of Iron and Steel.*** I; (2). *Two class hours per week.* A study of the sources of raw material, methods of obtaining the ore and the various processes of producing steel, rolling mill and foundry practice, the properties of special steels and their application to industry.

COURSE 42.—***Metallography.*** II; (2). *Four hours per week in laboratory with lectures. Must be preceded by Course* 41, This course consists of the microscopic examination of metals and alloys with special reference to the effects of heat treatment.

COURSE 43.—***Heat Treatment of Steel.*** II; (2). *Four hours per week in laboratory. Must be preceded by Course* 41. A laboratory study of modern methods in heat treatment of steel. Purposes of heat treating,

methods of temperature control, design of furnaces, annealing, hardening, tempering and case hardening.

Lectures, field work, identification of life forms, recitations and written exercises. Text: *Le Conte:* Salisbury and Chamberlain. For reference: The extremely valuable publications of the Wisconsin Geological Survey and the United States Geological Survey's Monographs and Bulletins.

GENERAL COURSES.

MATHEMATICS.

COURSE 5.—***Advanced Algebra.*** I, II; (5). A thorough but brief review of the foundations is given—(negative and irrational numbers, indices, proportion, graphic and analytic discussion of linear and quadratic equations)—after which the following topics are treated: Theory of limits, introduction to theory of series,—(arithmetic, geometric, binomial, logarithmic; series with undertermined co-efficients and their applications, tests of convergence),—elements of theory of equations, complex numbers.

COURSE 6.—***Trigonometry and Analytic Geometry.*** I, II; (5). *Trigonometry.*—The functions and their relations; functions of the sums, differences and multiples of angles; solution of all cases of plane and spherical triangles. Emphasis is laid on the practical side. *Analytic Geometry.*—A thorough study of graphic methods in general precedes this course, after which the line, the individual conics, and the general conic are considered with sufficient completeness. The spirit and methods of analytic geometry are emphasized and illustrations are drawn from the transcendental and higher algebraic curves whenever possible. The essentials of solid geometry are given.

COURSE 7.—***Differential Calculus.*** I, II; (4).

COURSE 8.—***Integral Calculus.*** I, II; (4). The direct and inverse operations are carried on in parallel. The fundamental formulas and methods of differentiating and integrating are followed by a geometric treatment of maxima and minima; then, applications to curves, surfaces and volumes are considered. Taylor's Theorem and the subject of series in general is put into the second semester, together with the applications of Calculus to functions of three or more variables, solid geometry and mechanics. Hyperbolic functions will be treated at some length; much problem work is exacted throughout.

COURSE 17.—***Differential Equations.***—The idea of this introductory course is to bring before the student types of the equations ordinarily met with in physics and mechanics, and to indicate the principles and methods employed for their solution. A certain amount of theory is necessary, but this will not be made the chief feature.

COURSE 19.—***Errors and Least Squares.***—*In connection with the Geodetic surveying of the Junior Civil Engineers, a two month's course in Least Squares is given;* the theory and formulas are developed rapidly, but sufficiently; and practical adjustments of observations of different or equal precision are then made. The lectures will be based on original notes, with references to Merriman's "Least Squares."

COURSE 30.—***Seminar.*** The object of the work of the Seminar is to bring together advanced students for special work, or for original reading,

or research in mathematical lines. The proceedings are informal; reports on assigned topics will be made in turn, under the direction of some member of the mathematical faculty.

[N. B.—Elementary courses in algebra and geometry are given in Marquette Academy and are in accordance with engineering entrance requirements.]

CHEMISTRY.

COURSE 1. ***General Inorganic Chemistry and Qualitative Analysis.*** I, II; (5). *Three lectures and two two-hour laboratory periods per week.* The fundamental laws and theories of chemistry. The elements, symbols and chemical formulae; the development of the chemical formula; chemical equations; the laws of Avogadro, Charles and Boyle; changes of gas volumes; gas densities; Gay Lussac's law of combining volumes; ionic theory; equilibrium; metallic and non-metallic elements and their compounds. This course covers general inorganic and qualitative chemical analysis. Taken by students of chemistry course, or by engineering students who have advanced standing in some other subject.

COURSE 5.—***Quantitative Analysis.*** I; (3). *Two three-hour laboratory and class room periods.* Through individual laboratory instruction, great stress is laid upon care and accuracy. The course is divided into two parts. The first half is devoted to gravimetric, and the remaining time to volumetric analysis.

(a) *Gravimetric.* A selected number of determination of basic and acid constituents to illustrate the different conditions of precipitation; washing, drying and weighing of precipitates; followed by methods of precipitation. The electrolytic determination of copper is included.

(b) *Volumetric.* The use and calibration of volumetric apparatus; selection and use of indicators; making and standardizing of volumetric solution; a selected number of determinations by acidimetric, alkalimetric, oxidimetric and precipitation methods.

COURSE 3. ***Organic Chemistry.*** I, II; (3). *Two lectures and one three-hour laboratory period.* Includes the apparatus and operations involved in organic chemical work; fractional distillation; extraction; crystallization; steam distillation; the determination of melting and boiling points; the general principles and theories of organic chemistry, and the physical and chemical properties of compounds of the aliphatic and aromatic series.

COURSE 108.—***Fuel Analysis.*** II; (1). The analysis of coal and coke. The determination of carbon, volatile and fixed; sulphur; ash; calorific value of calorimeter determination. Elementary analysis for carbon, hydrogen and nitrogen; calculation of calorific value.

COURSE 109. ***Gas Analysis.*** II; (1). The analysis of fuel and illuminating gases for carbon dioxide, hydro-carbons, oxygen, carbon monoxide, hydrogen, methane and nitrogen, by means of Hempel's and Orsat's apparatus. Calculations of calorific values.

COURSE 110.—***Iron and Steel Analysis.*** I; (2). The metallurgy and production of iron and steel; the testing of percentage of iron in iron ore, the percentage of manganese, sulphur, silicon and carbon in iron and

steel; the effects of these elements. Analysis of limestones and Portland cements for silica, iron and aluminum oxides, magnesia, lime, alkalies, anhydrous sulphuric acid, and total sulphur. Analysis of alloys and Babbitt metals.

COURSE 111.—***Water Analysis (Industrial).*** II; (1). The analysis of water for total solids, chlorides, silica, magnesia, lime, iron, alumina; hardness, temporary and permanent; fitness for boiler and other industrial uses. The softening of water.

COURSE 112. ***Water Analysis (Sanitary).*** II; (2). The analysis of potable waters, and tests of the methods of sewage purifications, including tests for residue; chlorides; nitrogen as ammonia, free and albuminoid; nitrogen as nitrates; nitrogen as nitrites; oxygen consumed for oxidation or organic matter; dissolved oxygen, and metallic impurities.

COURSE 113.—***Analysis of Oils.*** I, II; (2). The Analysis of Oils—Animal, Vegetable and Mineral; a study of specific gravity; flash and burning points; viscosity; melting points of solid fats; acid value; saponification value; iodine value; Reichert's meissel value; color tests with acids, etc.

PHYSICS.

COURSE 1.—***Elementary Physics (with Laboratory).*** I, II; (5).

This is an elementary and descriptive course designed to give Academy students a general idea of the principal phenomena and laws of physics. It is a prerequisite for Sophomores; and it is not given in the Freshman year of engineering, but is listed as an entrance requirement. Special students who lack this credit will be allowed to take this course in Freshman year.

COURSE 2.—***Mechanics, Molecular Physics and Heat.*** I; (4). *Prerequisite, Trigonometry, and Course* 1. *Four hours class.*

This course corresponds to the first half of general or college physics. It calls for a careful analysis of principles and laws, their development, their correlation, and their practical applications. Special attention is given to mechanics.

COURSE 3.—***Electricity, Light and Sound.*** II; (4). *Prerequisite, Course* 2. *Four hours class.*

In the continuation of General Physics the same analytic method is pursued in the discussion of the theories which underlie the phenomena of these subjects, and due emphasis is placed on the important application of the mechanics of waves and harmonic motion to these phenomena.

COURSE 102.—***Physical Measurements.*** I; (1). *Laboratory corresponding to Course* 2. *Two laboratory hours.*

Quantitative determination of physical constants; adjustments and use of instruments of precision, such as the micrometer microscope, cathetometer, chronograph, etc. Verification of the laws of impact, of torsion and rigidity, of the composition of harmonic motions, of gravity; Young's modulus, moment of inertia, etc. Determination of specific heats, coefficients of expansion, laws of gases; hygrometry.

COURSE 103.—***Physical Measurement.*** II; (1). *Laboratory corresponding to Course* 3. *Two laboratory hours.*

Experiments covering the laws of refraction, accurate measurements of indices of refraction, critical angle, magnifying power, photometry and spectrum analysis. Electro-static induction; theory of condenser; measurement of resistance; efficiency of electric motor; operation of alternator and transformer.

COURSE 6.—***Advanced Physics.*** I. ***Sound, Heat, Light.*** I; (2). *Prerequisites, Courses* 2, 3; *Mathematics* 6, 7, 8.

This course goes into the mathematical theories of these subjects as well as the refined methods of modern research; and due attention is given to practical applications in engineering and the industries generally.

COURSE 106—***Measurements in Sound, Heat, Light.*** I; (2). *Prerequisites, same as Course* 6.

A laboratory course, co-ordinate with Course 6, in which accurate measurements are made in such phenomena as stationary waves, Lissajous' curves, etc., vapor tension, calorimetry; Spectrometer, diffraction, grating, polariscope, bi-prism, photometer and interferometer.

COURSE 7.—***Advanced Physics*** II. ***Electricity.*** II; (2).

The mathematical side of the subject is made prominent, and modern theories and methods are discussed from this standpoint. Practical applications receive due attention.

COURSE 107.—***Electrical Measurements.*** I; (2). *Prerequisites, Course* 3 *and Mathematics* 8.

The development of electrical theories. The laboratory work includes the calibration of measuring instruments; resistance of conductors, electrolytes, dialectrics, magnetic properties of iron, magnetometer, self-induction, inductance and capacity, high and low potentials.

ASTRONOMY.

Young's Astronomy—historical, descriptive and practical. Lectures and recitations. For reference, Clerk's History of Astronomy, Newcomb's "The Stars"; Lockyear, Langley.

GEOLOGY.

General course in dybamic, structural, physiographic, historical, and economic geology. Principles of petrology, mineralogy and palenotology. Study of the field work of the Wisconsin Geological Survey. The College possesses a collection of the more important minerals and rocks; in addition to this the students have access to the Public Museum, the entire third floor of which is devoted to geology.

MODERN LANGUAGES.

COURSE 1.—***English.*** I; (3). The elements of good writing, supply of words, good use and choice of words, propriety, purity, elegance of diction; violations of rules, barbarisms, slang, solecisms, are thoroughly considered. After this, the study is made to bear on analysis of sentences, structures, clearness, precision, strength and harmony, and the periodic construction. Practice; daily written or oral exercises. Frequent original composition.

COURSE 2.—***English.*** II; (3). A continuation of Course 1. Various classes of compositions; narrations, descriptions, expositions, argument;

special problems of engineering writing; the business letter, reports, articles for technical journals. Oral and written work is constant.

For reference: *Genung, Coppens, Earle's* "Principles of Scientific Writing," *Woolley, Sypherd.*

COURSE 1.—***French.*** The work begins with oral exercises, and conducts the student through elementary grammar, including the more important irregular verbs; simple French prose should be understood and translated by the end of the year. Easy conversations are introduced.

COURSE 2.—***French.*** This course continues the preceding work in grammar and syntax, and has for its object the free reading of standard prose; exercises in translation from English into French are frequently assigned. The purpose is to fit the student for wider professional reading.

COURSE 1.—***German.*** The easier grammatical forms, as far as the irregular verbs, are gone over, with translations and practical simple oral work.

COURSE 2.—***German.*** This course continues the work of No. 21 in syntax and grammar, and by conversations, readings and themes prepares the student to read with some ease the standard German prose.

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ACCOUNTING.

COURSE I. ***General Accounting.*** I, II; (2).

COURSE II. ***Corporation Accounting.*** I, II; (2).

COURSE IV. ***Cost Accounting.***

These courses are offered in the College of Economics, but are open also to the students of the Engineering Department.

PHILOSOPHY.

COURSE I. ***Logic.*** I; (4).

COURSE II. ***Psychology.*** I; (4).

COURSE III. ***Ethics.*** II; (4).

These courses are offered in the Arts and Sciences Department, but are open also to the Engineering Department.

COURSE IV. ***Business Ethics.*** I, II; (1).

This course will embrace the fundamental principles of right and wrong, of justice and injustice, together with the application of these principles to the many phases of industry, commerce and finance.

The purpose of the course is to develop and strengthen an intelligent business conscience.

COURSE V. ***Business Psychology.*** I, II; (1).

A course in practical psychology, including a study of the nature and development of the powers and mental faculties which make for character and efficiency.


The Gramer
Trammell Co.

Marquette University

Milwaukee, Wisconsin

*College of Arts and Sciences.**

Courses in Letters, Sciences and Philosophy, leading to the Bachelor's degree in Arts and Sciences.

College of Applied Science and Engineering.

Courses in Civil, Mechanical and Electrical Engineering, leading to the degree of Bachelor of Science in Engineering.

School of Medicine.

A six-year course leading to the degree of Bachelor of Science and Doctor of Medicine.

College of Law.

a. The Day Law School, a four-year course leading to the degree of Bachelor of Laws;

b. The Evening Law School, a four-year course preparing for admission to the bar.

School of Dentistry.

A four-year course leading to the degree of Doctor of Dental Surgery.

*The R. A. Johnston College of Economics.**

a. A three-year course leading to the degree of Bachelor of Commercial Science;

b. A four-year course leading to the degree of Bachelor of Science in Economics;

c. A two-year Diploma Course.

*School of Journalism.**

Courses leading to the degree of Bachelor of Journalism, Bachelor of Arts in Journalism, Bachelor of Literature in Journalism and Bachelor of Science in Journalism, and a Diploma Course.

School of Pharmacy.

a. A two-year course leading to the degree of Graduate in Pharmacy;

b. A three-year course leading to the degree of Pharmaceutical Chemist;

c. A four-year course leading to the degree of Bachelor of Science in Pharmacy;

d. A short course in Pharmacy.

Training School for Nurses.

Conducted in connection with Trinity Hospital. A three-year course.

Marquette University Conservatory of Music.

Instruction in Piano, Vocal, Violin, Organ and all orchestral instruments. Theory and History of Music, Dramatic Art, Art of Expression, Public School Music, Ensemble and Sight-Reading.

Marquette Academy.

Preparatory Department, Classical and Commercial courses, Courses preparatory to Law, Medicine and Engineering.

Summer School.

Six weeks' session during July and August.

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*These Departments also have evening sessions.

PROFESSIONAL ETHICS.

In the engineering, as in the other professional schools of Marquette University, a course in professional ethics is deemed an essential part of the curriculum.

The need of sound principles of morality in all the professions is now quite widely recognized.

A physician, a laawyer, an economist, or an engineer whose moral development does not compare favorably with his mental equipment can never win the confidence of his fellow men. They look askance at him and deem his presence in the community a menace to the home and a source of fear to the state.

Marquette solves the problem that is occupying the minds of many leaders in the engineering profession. "The present-day problem in engineering education," to quote a prominent member of the faculty of an engineering college in Iowa, "is how to educate our engineers better in the fundamentals of successful education. High qualities of manhood are absolutely essential in the engineer; so are high technical qualifications. . . . . .

"The engineer must pass a double test and not fail in either manhood or technical requirements. . . . . .

"No person should be ranked as an engineer who does not possess the manhood qualifications in a satisfactory degree, and this requirement should be separate from and in addition to satisfactory technical qualifications."

The Faculty of Marquette University considers it necessary for the weal of the family and civil society to insist upon professional ethics for the engineering students.

Marquette University

BULLETIN

SERIES III, VOL. IV
MARCH, 1919
NUMBER 3

COLLEGE of APPLIED SCIENCE AND ENGINEERING

Your attention is called to the 5th year the Industrial Engineering course as shown on page 28 of the attached bulletin. This may be of interest in view of the action of the committee at Washington, D.C. of which you are a member.

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COLLEGE of APPLIED SCIENCE AND ENGINEERING

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1919

JANUARY

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MARCH, 1919
NUMBER 3

COLLEGE of APPLIED SCIENCE AND ENGINEERING

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CALENDAR

1919

Sept. 1-6—Entrance Examinations.
Sept. 8—Monday—Registration Sec. A. Shopwork begins Sec. B.
Sept. 9—Tuesday—Classes begin Sec. A.
Sept. 22—Monday—Registration Sec. B.
Sept. 23—Tuesday—Classes begin Sec. B.
Nov. 27—Thursday—Thanksgiving Day recess.
Dec. 22-27 incl.—Holiday recess Sec. B.
Dec. 30, 1919 to Jan. 3, 1920 inclusive—Holiday recess Sec. A.

1920

Jan. 10—Saturday—First Term ends Sec. A.
Jan. 24—Saturday—First Term ends Sec. B.
Jan. 26—Monday—Registration Sec. A.
Jan. 27—Tuesday—Second Term begins Sec. A.
Feb. 9—Monday—Registration Sec. B.
Feb. 10—Tuesday—Second Term begins Sec. B.
May 29—Friday—Second Term ends Sec. A.
May 30—Saturday—Memorial Day—Recess.
June 14—Saturday—Second Term ends Sec. B.
June 17—Tuesday—University Commencement.
June 15-20—Spring Recess—Sec. A.
June 22-27—Entrance Examinations.
June 22—Summer Term starts Sec. A.
June 29-July 4—Spring Recess—Sec. B.
July 6—Summer Term starts Sec. B.
Aug. 10-22—Vacation Sec. A.
Aug. 24-Sept. 5—Vacation Sec. B.

FORWORD

The College of Engineering is the natural outgrowth of the expansion of Marquette University. Its location is fortunate, in being situated in a large manufacturing center; many and varied engineering enterprises are constantly in progress; and the friendly relations between Marquette University and the different shops, factories, and transportation companies give the student advantages that are of great benefit to him in his future career.

There is a strong demand for trained engineers, especially in the Northwest, owing to the industrial activity of the region. To equip men to meet this demand is the object and purpose of the Engineering Department; this equipment demands not only a solid foundation of theory, but above all, thorough drill in the practical applications of theory, to fit the student to grapple with the new and difficult problems he will be likely to meet.

In drawing up the Courses of Study, careful comparison has been made of the courses, and of the actual experiences gained by members of the faculty, in other standard engineering schools. An engineer's training cannot be narrow, and for this reason great importance is attached to English; the relative value assgned to other branches at Marquette is in close accordance with the usage of the prominent Schools and Universities. Every attempt will be made to maintain a high level of study and efficiency, and there is no hesitation in dropping from the rolls students whose application to work is considered unsatisfactory.

INFORMATION

For information concerning the College of Applied Science and Engineering address the Registrar, 1115 Grand Avenue. Interested persons are urged to call at the Registrar's office whenever possible, since personal interviews are much more satisfactory than correspondence.

REGISTRATION

The office of the Registrar, first floor of the Administration building of Marquette University, 1115 Grand Avenue, is open for consultation daily, except Sunday, 9-12 A. M., 2-5 P. M.

Appointments will be made by the Registrar at hours agreeable to both parties, should the above hours be inconvenient.

Students are urged to register promptly at the specified time,

OFFICERS

REV. H. C. NOONAN, S. J.....*President*
REV. EUGENE RUDGE, S. J.....*Treasurer*
REV. JOHN B. KREMER, S. J.....*Faculty Regent*
J. C. PINNEY, JR., A.B., C.E.....*Dean*
KATHERINE L. FOLEY.....*Registrar*

FACULTY

REV. HERBERT C. NOONAN, S. J.,
Professor of Ethics.

JAS. C. PINNEY, JR., A.B., C.E.,
Dean of the College of Engineering.
Professor of Civil Engineering.

WM. D. BLISS, B.S. Ch.E.,
Professor of Mechanical Engineering.

REV. JOHN B. KREMER, S. J.,
Faculty Regent.
Professor of Physics and Astronomy.
Director of Physics Laboratory and Observatory.

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Director of Chemical Laboratories.

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Professor of Mathematics.

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Professor of English.

BERNARD A. ABRAMS,
Professor of Modern Languages.

REV. PAUL MUEHLMANN, S. J.,
Professor of Mathematics and Chemistry.

HARLAND C. WOODS, C.E.,
Assistant Professor of Civil Engineering.

REV. AUGUSTINE C. THEISSEN, S. J.,
Assistant Professor of Mathematics.

JOHN M. GREGG, B.S. E.E.,
Instructor in charge of Electrical Engineering.

EDWARD W. KANE, B.S. E.E.,
Instructor in Electrical Engineering and Drawing.

HORACE A. FROMMELT, S. J., B.S. E.E.,
Instructor in Mechanical Engineering.

GENERAL INFORMATION

LOCATION.

Marquette University is located in Milwaukee, the commercial and social center of the state of Wisconsin and the great manufacturing center of America. The city is attractively situated on Lake Michigan, 85 miles north of Chicago. It is readily accessible from all points; ample railroad connections are afforded by the Chicago & Northwestern, the Chicago, Milwaukee & St. Paul, the Soo Line, and three interurban lines. Also many points on Lake Michigan are in direct communication with Milwaukee by means of steamboat lines.

The advantages of Milwaukee are manifold:

Health: Is one of the most healthful cities in the United States. While the business section lies in a valley the elevations which surround it afford most delightful residence sections and excellent drainage. Deep water intakes extending far out into Lake Michigan afford a clear, cold and abundant supply of pure drinking water.

Homes: Is essentially a "city of homes." The percentage of those owning their own homes and maintaining lawns and gardens exceeds that of any other city of the Union. It has no congested or slum districts. The residence streets are especially beautiful, many being overarched with maple and elm trees.

Beauty: One of the sights which is a source of surprise and delight to visitors, is the Milwaukee bay. It suggests the Bay of Naples and is viewed from Juneau Park, near the heart of the city. No city on the Great Lakes has succeeded in reserving so beautiful a spot for public convenience and pleasure.

Parks and Boulevards: The park system is the admiration of all visitors. Every section of the city has its own park. Park area: City, 922 acres; adjacent to city, 320 acres. Boulevards, 21,640 feet. There are five public natatoriums, two bathing beaches, and also public golf links in the city.

Resorts: Within fifty minutes' ride of the famous Waukesha Springs; within two hours' ride, hundreds of Wisconsin's most beautiful lakes and summer resorts. Trains and interurban cars at all hours.

Civic: One of the most orderly and law abiding cities in the nation, having a lower percentage of vice and crime than any other large city.

Education: The standard of its school system is the highest. It maintains besides Marquette University, a state normal school, several

colleges, and is the first American city to maintain completely equipped trade schols as a part of the common school system.

Street Car Service: One hundred and one miles, most of it double track, within the one-fare limit. By a transfer system it is possible to ride twelve or more miles for a single fare, and one line carries many passengers nine miles without change of cars and a single fare.

Commercial and Industrial: The value of the year's production (1918) for fifteen leading industries was as follows:

Character.	Value of Products.
Iron, steel, heavy machinery	$155,696,044
Packed meat	68,200,000
Leather	45,000,000
Beer and malt tonics	35,000,000
Building	9,122,000
Coal and wood products	30,100,000
Boots and shoes	30,100,000
Malt	21,000,000
Electric and telephone supplies	29,233,000
Electric service	12,000,000
Agriculutral implements	10,310,000
Hosiery	12,300,000
Soap	8,000,000
Cigars and tobacco	5,600,000
Auto accessories, commercial trucks	31,000,000
Structural iron and bridges	9,150,000

It is safe to say that while Milwaukee is one of the largest industrial centers of the United States, it is also a city which produces a more diversified line of manufacture than any other. It has about 3,600 large factories, representing more than one hundred separate lines of industry; has the third largest railroad car works in the United States, the largest owned by a railroad corporation, is the largest tinware and enamelware producer in the world; manufactures 75 per cent of the heavy sawmill machinery made in the United States; has one-third of its population engaged in the manufacturing industries; furnishes the electric firing control for all battleships in the United States Navy and most of the automobile electric controls used in the country; has several of the largest engine building and heavy machinery plants in the United States; has the largest and best equipped plant for the manufacture of electric traveling cranes and hoists in the United States. It draws its supply of raw materials in convenient proximity; secures its fuel by the Great Lakes water route at low rates; has ample transportation connections to ship its

products to the four ends of the earth; enjoys a skillful, industrious and peaceful labor constituency.

As a commercial center it possesses some decided advantages. As the metropolis of the great state of Wisconsin, which holds a high place among the leading agricultural states of the Union, it has become an important distributing center for all commodities. Its jobbing and wholesale houses, which have grown into great commercial enterprises, have extended their trade connections far beyond the boundaries of the state.

Because of its location Marquette University offers unparalleled advantages to the student. He can gain an insight into the practical side of his future profession while still attending the classes.

M. U. CO-OPERATIVE ENGINEERING PLAN.

After mature deliberation, consultation with educators, practicing engineers, and industrial managers, and after a thorough investigation of Milwaukee's conditions and wonderful advantages, the trustees and faculty of the College of Applied Science and Engineering of Marquette University, have decided to install what is known as the "Cooperative System of Engineering Education."

OBJECT.

Recognizing that the engineer of today is not merely the man who is able to perform difficult computations and produce therefrom certain designs, but that he is rather the man who can, in addition to the above, so direct the forces of nature, and the labor of man, as to make them useful and beneficial to the social and economic welfare of mankind, the faculty of this school has decided to adopt this system. It is not only the one system which will present to the student, our future engineers, the true laws governing the various forces of nature, their co-relations, their possibilities, their limitations, and their economic applications, by the actual application of the laws as they are studied, but it is the one system which presents the opportunity to study and observe the actual conditions, limitations, etc., of the human element (labor) involved, so as to apply nature's forces to bring forth products useful to mankind. The object of the "M. U." Co-operative Engineering Course is to instill into the young man's mind the proper use of the forces of nature (human as well as inanimate) by giving the student an opportunity to actually apply these forces in conjunction with his study of the laws governing their application. This opportunity presented itself in the varied and wonderful industrial activity of Milwaukee. These industries were quick to see the great advantages of such a course, and extended to the school the facilities of their plants in hearty co-operation. Marquette's

laboratories are, therefore, the industrial plants of this vicinity. The general plan, as worked out by the faculty with the representatives of the co-operating industries, is as follows:

PLAN.

The student body will be divided into two sections, A and B. Those in section A will spend two weeks at employment directly bearing upon the school courses, while those in section B are attending school. At the end of a two weeks' period, section B will start work, while section A attends school. Every man in section A will have an alternate in section B, who will take his place of employment when section A starts a period in school. The kind of work done by the students is very important, and consequently the faculty, considering it a vital part of the educational work, decides on this matter. The work is so laid out that at the end of the five year course, the student has a clear insight into the various phases pertaining to that branch of engineering for which he is fitted or which he has chosen. The length of time spent at any one kind of work depends upon the work and the student's ability to grasp the principles involved. It may be said that the primary object of the co-operative course is not to make machinists or experts in any particular kind of employment, but rather to develop practical engineers.

With this purpose in view a number of firms have worked out schedules of employment for cooperative students. The following plan for Mechanical Engineers in one of the larger plants is a typical example:

Machine Shop	Lathe Planer Milling Machine Tool Room Bench Work	12	months
Power Plant		1½	months
Foundry		1½	months
Engine Erecting Shop		3	months
Engineering Dept. and Metallurgical Lab		6	months
Office and Accounting Dept		3	months
Sales Department		3	months

STUDENT-EMPLOYEES.

If this co-operative employment is to accomplish its purpose and put the student in touch with the actual conditions with which he must deal in the future, it is paramount that such employment must be real and not an imitation. The student, therefore, during his working period, will absolutely be an employee of the firm for which he is working, subject to such firm's rules, regulations and hours, and

the orders of its foremen in every respect. The faculty will exercise no direct control over the students while at work, merely supervising them to see that their general class of work, conduct, etc., are up to the high standard required by this institution.

CO-ORDINATION

The shop work will be correlated with the school by means of the co-ordination course. This course consists of the employment above described, with visits to various plants supplemented by class room discussions conducted so as to bring out the important points to ascertain whether or not the student is applying himself. In addition to the above, the co-ordination course includes the work of the students in their own Engineering Society. Attendance at and participation in the meetings of this society is required because of the realization that no man can properly fill a position of responsibility unless he is able to express his thoughts intelligently.

The co-ordination course is the connecting link between the theory taught in the classrooms and the application taught in the shops.

THE COURSE

It is evident that under such a system where the student spends one-half his time at school and the other half at employment, it is impossible to cover all of either the theory or its application in the old course of four years of eight months each. The "M. U." Co-operative Course, therefore, covers a period of five years of forty-eight weeks each. Each year is divided into two semesters of twenty weeks each and a summer term of eight weeks. There is a recess of two weeks between school years, and two recesses of one week each during the school year. These recesses occur consecutively and not simultaneously, for the two sections of the student body.

By such a program it has been found possible to easily cover all the fundamentals which both educators and practicing engineers agree are essential for the proper training of an engineering student. In addition the student is given a clear insight into engineering methods, or the application of what he is learning in school.

COMPENSATION

While the object of this system is purely educational, and the work for each student is so chosen as to give him a thorough knowledge of his particular branch of the profession, nevertheless the compensation received from his shopwork may often be the means of enabling a young man to complete his schooling. While the student is employed, as before stated, he is in every respect an employee of

the firm for which he is working. He receives compensation for his work and such compensation is paid directly to him and is his. The amount earned by any particular student varies according to the kind of work, the student, and the length of employment. It will in general average around $250.00 per year. The University does not in any way attempt to control this phase of the subject. The amount earned, however, should pay one-half of the average student's expenses.

EQUIPMENT

The College of Applied Science and Engineering is well equipped with laboratories for all of the courses offered. The Chemical laboratory occupies the entire fourth floor of the Administration building, while the Physics laboratory occupies the entire third floor of the same building. Both of these have lecture halls equipped for demonstrations. The Astronomical observatory is located in the Administration building, and is well equipped for all ordinary observations and student work.

The Engineering laboratories proper are located in the Engineering building. These laboratories are thoroughly equipped for carrying on the college experiments such as the tests of steam and gas engines to obtain their efficiency, power, performance, fuel consumption, etc., etc.

The Mechanical Engineering laboratory is equipped with both high speed and Corliss engines, gasoline and kerosene engines, pumps, etc. Besides being able to make efficiency and performance tests on all these engines, it is also equipped for testing the quality of steam, fuel analysis, calibrating guages, etc., and make complete boiler tests.

The Electrical Engineering laboratory is similarly equipped for making performance and efficiency tests, characteristics, etc., on the various types of generators, motors, transformers, converters, rectifiers, and the various other electrical appliances for both Direct and Alternating Current.

The Civil Engineering laboratories are equipped for testing the various materials of engineering structure, such as the metals, brick, sand, cement, etc., etc., in tension, compression, and cross-bending. The Hydraulic laboratory permits the testing of the flow of water and its measurement by weirs, pitometers, venturi meters, orifices, etc.

There is a good assortment of tapes, rods, levels, transits, compasses, plane tables, etc., with which to give the students thorough training in plane, topographic and railroad surveying.

LIBRARY FACILITIES.

The magnificent public library of the city, almost adjoining the School of Dentistry and Pharmacy, is within two blocks of the Schools

of Journalism, Arts and Sciences, Law, Economics, Engineering. The arrangement of the library is an ideal one for students, who have access to all the books for consultation and study, and may, with special privilege, take home with them as many books as are necessary for the preparation of essays, debates, etc. The main library and its eight branches contain 325,000 volumes.

The Science room has about 25,000 volumes. On different shelves are books on Natural Science, Mathematics, Physics, Electricity, Chemistry, Geology, Biology, Archeology, Paleontology, Botany, Zoology, Birds, Mammals, Engineering and Agriculture.

In the History room are more than 40,000 volumes, including 15,000 on Sociology, 7,177 on Travel, 11,087 on Biography, and 11,900 on History. The Philosophy room contains about 5,000 volumes.

The Literature room contains 38,000 volumes, among which are American, English, French, German, Grecian, Roman, Italian, Spanish, Portuguese literatures, also a goodly number of Swedish, Danish, Dutch, Flemish, Semitic and Slavic and many books of Japanese, Chinese and Celtic literatures.

The College Library contains nearly 13,000 volumes. Its circulating department, accessible to the members twice a week, comprises standard English works, carefully selected with a view to the needs of the College students.

The library of the School of Applied Science and Engineering contains the latest volumes of all leading periodicals. The bond reports of the A. S. M. E. and many Engineering texts are available.

MUSEUM.

The Museum of the city of Milwaukee is within three minutes' walk of the University. The collection is one of the largest and finest in the United States, and contains hundreds of thousands of zoological, botanical, minerological and other specimens.

ENTRANCE REQUIREMENTS

ADMISSION.

All applicants for admission must present evidence of good moral character and, if they come from another college, a certificate of honorable dismissal.

Admission by Certificate. A certificate from the principal of an accredited high school in which a student has been prepared for college will be accepted instead of examinations in the subjects offered for admission.

REQUIREMENTS FOR ADMISSION.

All candidates for a degree must present entrance credits amounting to the number of units specified in the course selected. A unit represents a year's study in a high school subject pursued four or five times a week.

SUBJECTS ACCEPTED FOR ADMISSION.

Latin.

(1) Grammar.—The entire Latin Grammar, including a knowledge of all regular syntactical constructions; translations into Latin, at sight, of complex English sentences, entailing the application of rules for relative clauses, indirect discourse and conditional sentences.

(2) Composition.—Translation into Latin of easy continuous prose, based on Caesar's Gallic War and on the Letters and Orations of Cicero.

(3) Authors.—Caesar: De Bello Gallico, four books. Ovid: Metamorphoses and Tristia. Cicero: The Orations against Cataline. Virgil: Aeneid, six books.

Greek.

(1) Grammar.—Etymology complete (including the irregular and defective forms); the rules of accents; syntax; the Homeric dialect.

(2) Composition.—Translation into Greek of simple English sentences based on Xenophon's Anabasis.

(3) Authors. — Xenophone; Anabasis, four books. Homer, Iliad, three books, or Odyssey, three books.

English—Rhetoric.

The candidate must be prepared on the matter contained in a standard text-book such as Hill, Coppens, Williams, Genung, Carpenter, Thorndike, Brooks.

Composition.—A brief prose composition will be required, evi-

dencing proficiency in the writing of clear, idiomatic English. The subject will be taken from the candidates' experience, or based on the books he presents for examination.

Fair penmanship and accurate spelling will be considered as essential preliminary requirements.

English.

Texts prescribed for reading and study: Two plays of Shakespeare; Burke's Conciliation with the Colonies, or American Taxation; Irving's Sketch Book; one essay of Macaulay; Scott's Lady of the Lake; Goldsmith's Deserted Village; Tennyson's The Passing of Arthur; Lowell's Vision of Sir Launfal; Coleridge's Ancient Mariner.

The applicant should make himself familiar with the characters, the plot, incidents and characteristic diction of each work. Equivalents will be accepted.

French, German, Spanish.

1. Elementary grammar, easy prose and themes.
2. Syntax, moods, complex sentences, easy prose writing.
3. Good ready knowledge of standard prose, with syntax.
4. Acquaintance with classics and lyric poets.

The texts this year at Marquette are Chardenal (French) and Becker (German). Equivalent text-books must be used by students.

Spanish.

(Same as for first two years of German and French.)

History.

(1) Ancient History, including the history of the Oriental nations, Greece and Rome.

(2) Modern History from the foundation of the Holy Roman Empire to the present time.

(3) United States History and Civics.

History and Civics.

1. United States, or English History.
2. Ancient History.
3. European History.

Civics counts as ½ unit and may be combined with History.

Elementary Sciences.

The requirements are those of the standard High School texts, such as "McPherson and Henderson" (in Chemistry); "Martin" (in Physiology); "Linville and Kelly" or "Jordan and Gellogg" (in Zoology); "Atkinson" or "Bergen" (in Botany); "Milliken and Gale" or "Mann and Twiss" or "Carhart and Chute" (in Physics); "Davis" or "Tarr" (in Physical Geography); "Howe" or "Todd" or "Young"

(in Astronomy); "Norton" or "Tar" (in Geology). Work in Biology (eg. g., "Bailey & Coleman") may be offered as ½ unit in Zoology and ½ unit in Botany. All notes, note books, laboratory work, etc., in the above subjects, must be presented, especially in Physics, Chemistry and Geology, where they are absolutely required as essential to a proper course.

Algebra.

Fundamental operations, factoring, fractions, linear equations, radicals and exponents, quadratics, graphs, and problems involving all these are required; additional work in logarithms, elementary series, simultaneous quadratics, ratio and variations, binomial theorum, may be offered as ½ unit.

Trigonometry.

The six functions, and their relations, addition theorems, simpler transformations, and the solution of plane triangles, right and oblique.

Geometry.

Any standard text; original demonstrations, loci, and numerical work are of great importance.

Vocational Subjects.

Such as Drawing, Commercial Law, Commercial Geography, Bookkeeping and Manual Training, are accepted with reluctance. A student offering such credits must furnish a comprehensive and full account of these studies and of the number of recitation or class hours spent in them, together with specimens of work done. Tests may be exacted if any doubt remains; and in no case will the total credits in this group be more than 2.

Admission may likewise be had by transfer from another recognized college or university, on presentation of an official statement of the student's standing, and a certificate of honorable dismissal.

Applicants, not graduates of an accredited high school or transferred in good standing from an institution of equal rank, are subject to entrance examinations, which are held in September and June. Detailed information as to the hour and place of such examinations will be furnished to applicants at the Registrar's office.

Special students, not candidates for a degree, may be admitted to certain courses, provided they are over 19 years of age, and show the ability to pursue their studies with profit. The credit to be assigned for such work will be determined upon by the Dean of the department.

UNITS REQUIRED FOR ADMISSION.

The following units are required of all degree students:

Elementary Algebra ...1½ units	English Literature .....1 unit
Plane Geometry .....1 unit	History. . . . . .1 unit
Solid Geometry ..... ½ unit	Elementary Physics .....1 unit
English Composition ..1 unit	Electives. . . . . .7 units

ELECTIVE UNITS.

The elective subjects that may be presented to complete the required units must be taken from the following list:

English	1 to 2 units
Spanish, French, German	1 or 2 units
Latin, Greek	1 to 2 units
History (not more than four units in all):	
Ancient History	1 unit
Medieval and Modern History	1 unit
English History	1 unit
United States History	1 unit
Science (not more than four units in all):	
Biology	1 unit
Botany	1 unit
Chemistry	1 unit
Physics	1 unit
Physical Geography and Geology	1 unit
Zoology	1 unit
Physiology	½ unit
Algebra (intermediate)	½ unit
Trigonometry	½ unit
Agriculture	1 unit
Drawing	1 unit
Vocational subjects and Manual Training	2 units
Music:	
Appreciation of Harmony	1 unit

Limitations.—Not more than four units will be accepted in any one subject. Students desiring credit in a foreign language must have at least two units in the subject. One unit of credit for a second foreign language will be given if the student has at least three units in the first language.

No Collegiate Credit is Given for High School Work.

SPECIAL STUDENTS.

The requirements as a special student will not be as rigid as for regular students, but will be governed in each case by the judgment of the Dean and faculty, concerning the applicant's fitness profitably to pursue the particular subject or subjects he may wish to follow.

Every applicant must present to the Dean a detailed and certified statement of his previous studies.

Special students, not candidates for a degree, will be admitted to such courses offered as their qualifications warrant. The Dean will be the judge of the applicant's fitness to pursue desired subjects. A

Special student may become a candidate for a degree if he has fulfilled the entrance requirements.

No one will be admitted as a Special student unless he has passed his twentieth birthday.

ADVANCED STANDING.

Due credit will be allowed for advanced work done at the other Universities and Colleges of accepted standing, when work is closely similar to courses given in this school. Application for advanced standing may be made personally or in writing and should be accompanied by a detailed statement from the proper authority of the nature of the work for which credit is asked.

SPECIAL LECTURES

by engineers, faculty members and invited guests are given to the engineering students at intervals during the year; many of these lectures are illustrated.

EVENING COURSES

both advanced and elementary, are conducted by the Engineering Department in conjunction with the College of Arts and Sciences. General courses in Astronomy, Chemistry, English, German, French, Elementary and Higher Mathematics, Mechanical Drawing and Physics are offered; a fuller account will be found in the "Bulletin of Evening Courses of Marquette University." These courses are of advantage to prospective students or to those working for degrees.

SUMMER COURSES

are likewise offered at Marquette University (in July and August). They afford an opportunity to conditioned or prospective students for making up their deficiencies. A separate "Bulletin of Summer Courses" can be had from the Registrar's office.

EXPENSES

A matriculation fee of $5.00 is charged every student when he decides to enter the University. This is not a recurrent fee and is charged each student but once during his course.

An athletic fee of $5.00 is charged every student annually, which admits him to all local games. This fee is due in advance before entering the first semester.

The regular tuition is $125.00 per year payable in advance as follows: $75.00 before beginning the first semester, and $50.00 before beginning the second semester.

A chemistry fee of $2.50 per year (not including breakage), is charged.

Books and instruments will cost about $30.00 for the Freshman year, and about $25.00 thereafter.

Board and room may be secured in close proximity to the University at about $6.00 per week.

The dues of the student's Engineering Society are $1.00 per semester, $2.00 per year.

It is impossible to estimate such items as laundry, social activities and other such personal expenses as they vary greatly for different students.

The average yearly expense outside of these personal expenses may be summed up as follows:

Tuition	$125.00
Athletic fee	5.00
Chemistry (not including breakage)	2.50
Books and stationery	25.00
Engineering Society	2.00
Board and room	288.00
Matriculation (only once)	$ 5.00

A goodly portion of this, though not all of it, can be met by the earnings of the student during his shop periods.

REGULATION.

Every student shall carry at least 12 credit hours of work prescribed for the class in which he registers, otherwise he will be classed as a special. Reports are sent to parents or guardians at regular intervals regarding the student's standing and progress.

A final average below 60 for a semester's work in any subject will be considered a failure, and the student will be required to repeat the work in that subject at the earliest opportunity.

A final average above 60 and below 70 for a semester's work in any subject conditions the student. A condition will not prevent the student from pursuing advanced subjects, but the condition must be removed before the subject is repeated in the regular course, otherwise the student must repeat the subject. Examinations for the removal of conditions are held in January, June and September, and for each examination there is a special fee of $1.00. Conditional examinations may, on special occasions be held at other than the above times, but the fee for such special examinations will be $2.00. All fees are payable in advance. The student will be held responsible for arranging to remove his own conditions.

A final average of 70 or over for a semester's work in any subject entitles the student to credit in that subject. This credit, however, may be partially or wholly withdrawn in case the student shows

by his work in future courses that he lacks the necessary understanding in the prerequisite subject. In this case the student will be required to take such special work or repeat such portions of the prerequisite subject, as the Dean may prescribe.

A student who fails to complete his laboratory or drawing assignments within the time prescribed, will have his credits in such uncompleted subjects withheld until he has completed all such work to the satisfaction of the professor in charge. In case of failure to complete the work by the end of the next succeeding semester, the semester's work in the incompleted subject must be repeated.

PROBATION.

A student who fails to obtain a passing grade (70 or over) in one-half his work at the mid-term or at the end of any semester will be placed on probation for the next half-semester. If, at the end of this probation period he is still below passing grade in one-half his work, he will be dropped from the school.

A student who is placed on probation for the second time, may at the discretion of the faculty, be dropped from the school.

Any student desiring special consideration, or exceptions from the above rules, must present his request in writing, with reasons, to the faculty, through the Dean. All such exceptional cases will be acted upon by the faculty as a whole.

ABSENCES.

Absences from classes without good and sufficient reasons will not be tolerated under any circumstances. In cases of excusable absences, the student will be given an opportunity to make up the lost work, but a continuation of absences will result in dismissal from the institution.

Absences from shop work will not be tolerated under any circumstances. If a student leaves his place of employment, "quits his job," without faculty consent, he is liable to be dismissed from the school, or to receive such other punishment as the Dean may deem fit.

DEGREES.

The University grants the professional degrees of Chemical Engineer (Ch.E.), Civil Engineer (C.E.), Electrical Engineer (E.E.), and Mechanical Engineer (M.E.), to students who have successfully completed the five-year cooperative course in any of the respective branches.

SCHEDULE OF COURSES

CHEMICAL ENGINEERING

FIRST YEAR.

First Term		Hours Per Wk.
Math. 5	Advanced Algebra	6
Chem. 1	General Chemistry	7
English 1	English and Public Speaking	3
C-1	Coordination	1
G. E. 101	Elementary Engineering	4
Drawing 1	Engineering Drawing	4

Second Term		Hours Per Wk.
Math. 6 & 7	Trig. and Analytical Geometry	6
Chem. 2	General Chemistry	7
English 2	English and Public Speaking	3
C-2	Coordination	1
C. E. 101a	Surveying	3
Drawing 2	Engineering Drawing	4

Summer Term.		Hours Per Wk.
Drawing 3	Engineering Drawing	10
Chem. 3	Qualitative Analysis	12
C E. 102a	Surveying	12

SECOND YEAR.

First Term		Hours Per Wk.
Math. 7a	Analytical Geometry	4
Math. 8	Calculus	2
Chem. 5	Quantitative Analysis	4
Physics 2	Mech., Molecular Physics and Heat	4
Drawing 4	Descriptive Geometry	5
C-3	Coordination and English	2
Physics 102	Physical Measurements	4

Second Term		Hours Per Wk.
Math. 8a	Calculus	4
Chem. 5a	Quantitative Analysis	4
Physics 3	Electricity, Heat and Light	4
Physics 103	Physical Measurements	4
M. E. 201	Heat Engines	3
Ch. E. 100	Metallurgy of Iron and Steel	2
C-4 M	Coordination and English	2
M. E. 204	Mechanical Laboratory	4

Summer Term		Hours Per Wk.
Mech. 101	Statics	5
Ch. E. 100	Metallurgy of Iron and Steel	3
Ch. E. 209	Fuel and Gas Analysis	12
M. E. 201	Heat Engines	3

THIRD YEAR—(Chemical Engineering).

First Term		Hours Per Wk.
Math. 9	Calculus, Differential Equations	5
Physics 3a	Electricity, Heat and Light	3
Physics 103a	Physical and Electrical Measurements	6
Mech. 102	Statics	1
Mech. 103	Mechanics of Materials	4
C-5	Coordination and English	2

Second Term		Hours Per Wk.
Mech. 104	Mechanics of Materials	4
Mech. 105	Dynamics	2
M. E. 203	Mechanical Laboratory	4
M. E. 100	Mechanism	6
E. E. 130	Direct Currents	2
Ch. E. 201	Inorganic Technical Analysis	8
S-6	Coordination and English	2

Summer Term		Hours Per Wk.
Mech. 106	Dynamics	2
E. E. 132	Direct Currents	6
Ch. E. 210	Iron and Steel Analysis	12

FOURTH YEAR

First Term		Hours Per Wk.
Ch. E. 204	Applied Thermal Chemistry	3
M. E. 301	Principles of Accounting	3
Chem. 6	Organic Chemistry	6
Mech. 201	Hydraulics	5
Ch. E. 200	Technical Pyrometry	4
E. E. 133 and 135	Electrical Laboratory	4
C-7	Coordination and English	2

Second Term		Hours Per Wk.
Chem. 6a	Organic Chemistry	6
E. E. 134	Alternating Currents	5
Ch. E. 208	Assaying	4
Mech. 302	Testing Materials Laboratory	4
E. E. 135	Electrical Laboratory	4
Mech. 301	Engineering Materials	3
C-8	Coordination and English	2

Summer Term		Hours Per Wk.
C .E. 305	Structural Design	15
Ch. E. 202	Organic Technical Analysis	15

FIFTH YEAR—(Chemical Engineering).

First Term		Hours Per Wk.
Ch. E. 202	Organic Technical Analysis	4
M. E. 303	Industrial Management	3
Ch. E. 206	Applied Electro Chemistry	6
Ch. E. 104	Heat Treatment of Steel	6
G. E. 201	Economics	3
C-9	Coordination and English	2
	Electives	2

Second Term		Hours Per Wk.
G. E. 203	Contracts and Specifications	3
Chem. 7	Physical Chemistry	6
Ch. E. 207	Industrial Chemistry	3
Ch. E. 102	Metallography	6
M. E. 303a	Industrial Management	2
G. E. 301	Engineering Ethics	2
	Electives	3

CIVIL ENGINEERING

FIRST YEAR.

First Term		Hours Per Wk.
Math. 5	Advanced Algebra	6
Chem. 1	General Chemistry	7
English 1	English and Public Speaking	3
C-1	Coordination	1
G. E. 101	Elementary Engineering	4
Drawing 1	Engineering Drawing	4

Second Term		Hours Per Wk.
Math. 6 & 7	Trig. and Analytical Geometry	6
Chem. 2	General Chemistry	7
English 2	English and Public Speaking	3
C-2	Coordination	1
C. E. 101	Surveying	3
Drawing 2	Engineering Drawing	4

Summer Term		Hours Per Wk.
Drawing 3	Engineering Drawing	10
Chem. 3	Qualitative Analysis	12
C. E. 102	Surveying	12

SECOND YEAR—(Civil Engineering).

First Term		Hours Per Wk.
Math. 7a	Analytical Geometry	4
Math. 8	Calculus	2
Chem. 5	Quantitative Analysis	4
Physics 2	Mechanics, Molecular Physics and Heat	4
Physics 102	Physical Measurements	4
Drawing 4	Descriptive Geometry	5
C-3	Coordination and English	2

Second Term		Hours Per Wk.
Math. 8a	Calculus	4
Chem. 5a	Quantitative Analysis	4
Physics 3	Electricity, Light and Heat	4
Physics 103	Physical Measurements	4
C. E. 103	Plane Surveying	3
Ch. E. 100	Metallurgy of Iron and Steel	3
C-4	Coordination	2

Summer Term		Hours Per Wk.
Mech. 101	Statics	5
C. E. 104	Plane Surveying	20

THIRD YEAR.

First Term		Hours Per Wk.
Math. 9	Calculus—Differential Equations	5
Physics 6a	Electricity, Light and Heat	3
Physics 103a	Physical & Electrical Measurements	6
Mech. 102	Statics	1
Mech. 103	Mechanics of Materials	4
C. E. 105	Topographic Surveying	3
C-5	Coordination and English	2

Second Term		Hours Per Wk.
Mech. 104	Mechanics of Materials	4
Mech. 105	Dynamics	2
C. E. 106	Topographic Surveying	9
C. E. 201	Railroad Curves	3
M. E. 210	Engines and Boilers	3
C-6	Coordination and English	2

Summer Term		Hours Per Wk.
C. E. 202	Railroad Location	20
Mech. 106	Dynamics	2

FOURTH YEAR—(Civil Engineering).

First Term		Hours Per Wk.
Mech. 201	Hydraulics	5
C. E. 401	Highways	3
C. E. 301	Theory of Structures	6
C. E. 203	Railroad Location	6
M. E. 211	Mech. Eng. Laboratory	6
C-7	Coordination and English	2

Second Term		Hours Per Wk.
Mech. 302	Materials Testing Laboratory	4
C. E. 302	Structural Design	8
C. E. 204	Railroad Const. and Maintenance	4
C. E. 350	Masonry Construction	3
Mech. 301	Engineering Materials	3
C. E. 351	Reinforced Concrete	2
C-8	Coordination and English	2

Summer Term		Hours Per Wk.
C. E. 205	Railroad Location and Construction	8
C. E. 303	Structural Design	10
C. E. 352	Reinforced Concrete	10

FIFTH YEAR.

First Term		Hours Per Wk.
E. E. 136	Direct Currents	3
E. E. 137	Electrical Engineering Laboratory	4
C. E. 353	Reinforced Concrete	3
C. E. 354	Reinforced Concrete Design	6
G. E. 201	Economics	3
Mech. 303	Materials Testing	4
C. E. 402	Water Supply	3
C-9	Coordination and English	2

Second Term		Hours Per Wk.
E. E. 138	Alternating Currents	3
E. E. 139	Electrical Engineering Laboratory	4
G. E. 203	Contracts and Specifications	3
C. E. 304	Bridge Design	12
C. E. 356	Foundations	2
G. E. 202	Business Organization	2
G. E. 301	Engineering Ethics	2

ELECTRICAL ENGINEERING

FIRST YEAR.

First Term		Hours Per Wk.
Math. 5	Advanced Algebra	6
Chem. 1	General Chemistry	7
English 1	English and Public Speaking	3
C-1	Coordination	1
G. E. 101	Elementary Engineering	4
Drawing 1	Engineering Drawing	4

Second Term		Hours Per Wk.
Math. 6 & 7	Trig. and Analytical Geometry	6
Chem. 2	General Chemistry	7
English 2	English and Public Speaking	3
C-2	Coordination	1
C. E. 101	Surveying	3
Drawing 2	Engineering Drawing	4

Summer Term.		Hours Per Wk.
Drawing 3	Engineering Drawing	10
Chem. 3	Qualitative Analysis	12
C. E. 102	Surveying	12

SECOND YEAR.

First Term		Hours Per Wk.
Math. 7a	Analytical Geometry	4
Math. 8	Calculus	2
Chem. 5	Quantitative Analysis	4
Physics 2	Mech. Molecular Phys. and Heat	4
Drawing 4	Descriptive Geometry	5
C-3	Coordination and English	2
Physics 102	Physical Measurements	4

Second Term		Hours Per Wk.
Math. 8a	Calculus	4
Chem. 5a	Quantitative Analysis	4
Physics 3	Electricity, Heat and Light	4
Physics 103	Physical Measurements	4
C. E. 103	Plane Surveying	4
Ch. E. 100	Metallurgy of Iron and Steel	2
C-4	Coordination and English	2

Summer Term		Hours Per Wk.
Mech. 101	Statics	5
C. E. 104a	Plane Surveying	10
Ch. E 209	Fuel and Gas Analysis	12

THIRD YEAR—(Electrical Engineering).

First Term		Hours Per Wk.
Math. 9	Calculus; Differential Equations	5
Physics 3a	Electricity, Light and Heat	3
Physics 103a & 107	Physical and Elec. Measurements	6
Mech. 102	Statics	1
Mech. 103	Mechanics of Materials	4
C-5	Coordination and English	2

Second Term		Hours Per Wk.
Mech. 104	Mechanics of Materials	4
Mech. 105	Dynamics	2
M. E. 100	Mechanism	6
M. E. 201	Heat Engines	3
E. E. 102	Electricity and Magnetism	5
C-6	Coordination and English	2

Summer Term		Hours Per Wk.
Mech. 106	Dynamics	5
E. E. 104	Direct Current Machines	5
E. E. 103	Electrical Laboratory	10
M. E. 201a	Heat Engines	3

FOURTH YEAR.

First Term		Hours Per Wk.
E. E. 106	Direct Current Problems	3
E. E. 107	Electrical Laboratory	6
E. E. 124	Secondary Cells	2
Mech. 201	Hydraulics	5
M. E. 200	Thermodynamics	4
M. E. 202	Mechanical Laboratory	4
C-7	Coordination and English	2

Second Term		Hours Per Wk.
E. E. 108	Alternating Currents	5
E. E. 109	Electrical Design	4
E. E. 107a & 111	Electrical Laboratory	4
Mech. 301	Engineering Materials	3
Mech. 302	Materials Testing Laboratory	4
M. E. 203	Mechanical Laboratory	4
C-8	Coordination and English	2

Summer Term		Hours Per Wk.
E. E. 110	Alternating Current Machines	5
E. E. 111a	Electrical Laboratory	10
C. E. 305	Structural Design	15

FIFTH YEAR—(ELECTRICAL ENGINEERING).

FIRST TERM		Hours Per Wk.
E. E. 110a	Alternating Current Machinery	5
E. E. 113	Electrical Laboratory	6
E. E. 116 or 118	Elective	5
E. E. 122	Electric Railway Engineering	3
E. E. 115	Electrical Design	4
G. E. 201	Economics	3
C-9	Coordination and English	2

SECOND TERM		Hours Per Wk.
E. E. 112	Alternating Current Problems	3
E. E. 116a or 118a	Elective	5
E. E. 122a	Electric Railway Engineering	5
G. E. 202	Business Organization	2
G. E. 203	Contracts and Specifications	3
G. E. 301	Engineering Ethics	2
	* Electives	8

* Four hours of the electives must be chosen from E. E. 114, 120 or 126, and four hours from E. E. 117 or 119.

MECHANICAL ENGINEERING

FIRST YEAR.

FIRST TERM		Hours Per Wk.
Math. 5	Advanced Algebra	6
Chem. 1	General Chemistry	7
English 1	English and Public Speaking	3
C-1	Coordination	1
G. E. 101	Elementary Engineering	4
Drawing 1	Engineering Drawing	4

SECOND TERM		Hours Per Wk.
Math. 6 & 7	Trig. and Analytical Geometry	6
Chem. 2	General Chemistry	7
English 2	English and Public Speaking	3
C-2	Coordination	1
C. E. 101a	Surveying	3
Drawing 2	Engineering Drawing	4

SUMMER TERM.		Hours Per Wk.
Drawing 3	Engineering Drawing	10
Chem. 3	Qualitative Analysis	12
C. E. 102a	Surveying	12

SECOND YEAR—(Mechanical Engineering).

First Term		Hours Per Wk.
Math. 7a	Analytical Geometry	4
Math. 8	Calculus	2
Chem. 5	Quantitative Analysis	4
Physics 2	Mech., Molecular Phys. and Heat	4
Drawing 4	Descriptive Geometry	5
C-3	Coordination and English	2
Physics 102	Physical Measurements	4

Second Term		Hours Per Wk.
Math. 8a	Calculus	4
Chem. 5a	Quantitative Analysis	4
Physics 3	Electricity, Heat and Light	4
Physics 103	Physical Measurements	4
M. E. 201	Heat Engines	3
Ch. E. 100	Metallurgy of Iron and Steel	2
C-4	Coordination and English	2
M. E. 202	Mechanical Laboratory	4

Summer Term		Hours Per Wk.
Mech. 101	Statics	5
M. E. 201a	Heat Engines	3
Ch. E. 209	Fuel and Gas Analysis	12
Ch. E. 100	Metallurgy of Iron and Steel	3

THIRD YEAR.

First Term		Hours Per Wk.
Math. 9	Calculus; Differential Equations	5
Physics 3a	Elec. Heat and Light	3
Physics 3a & 107	Physical and Electrical Measurements	6
Mech. 102	Statics	1
Mech. 103	Mechanics of Materials	4
C-5	Coordination and English	2

Second Term		Hours Per Wk.
Mechanics	Mechanics and Materials	4
Mechanics	Dynamics	2
M. E. 203	Mechanical Laboratory	4
M. E. 100	Mechanism	6
E. E. 130	Direct Currents	3
M. E. 200	Thermodynamics	4
C-6	Coordination and English	2

Summer Term		Hours Per Wk.
Mech. 106	Dynamics	5
E. E. 132	Direct Current Machinery	6
Ch. E. 210	Iron and Steel Analysis	12

FOURTH YEAR—(Mechanical Engineering).

G. E. 101	Economics	3
M. E. 301	Principles of Accounting	3
M. E. 302	Commercial Law	3
Mech. 201	Hydraulics	5
M. E. 101	Elements of Machine Design	4
E. E. 131	Electrical Laboratory	4
C-7	Coordination and English	2

Second Term		Hours Per Wk.
M. E. 301a	Principles of Accounting	3
M. E. 302a	Commercial Law	3
Mech. 301	Engineering Materials	3
E. E. 134	Alternating Currents	5
E. E. 131a & 135	Electrical Laboratory	4
Mech. 302	Materials Testing Laboratory	4
C-8	Coordination and English	2

Summer Term		Hours Per Wk.
C. E. 205	Structural Design	15
*Ch. E. 104	Heat Treatment of Steel	15

*Students taking Steam and Gas Engineering or Railway Engineering will substitute for Ch. E. 101, E. E. 135a.

FIFTH YEAR.—INDUSTRIAL ENGINEERING.

First Term		Hours Per Wk.
M. E. 303	Industrial Management	5
M. E. 304	Production Engineering	3
M. E. 305	Credits and Collections	3
M. E. 306	Corporation Finance	4
M. E. 307	Business Correspondence	2

Second Term		Hours Per Wk.
M. E. 303a	Industrial Management	3
M. E. 304a	Production Engineering	3
*M. E. 308	American Government	3
M. E. 206	Heating and Ventilating	6
G. E. 301	Engineering Ethics	2

*Advertising, M. E. 309 may be substituted for M. E. 305 in the first semester and Practical Salesmanship and Sales Administration M. E. 310 may be substituted for M. E. 308 in the second semester.

*FIFTH YEAR.—RAILWAY MECHANICAL ENGINEERING.**

First Term		Hours Per Wk.
M. E. 207	Power Plants	7
M. E. 303	Industrial Management	5
M. E. 304	Production Engineering	3
M. E. 214	Railway Mechanical Engineering	3
E. E. 122	Electrical Railway Engineering	3
C-7	Coordination and English	2

Second Term		Hours Per Wk.
M. E. 303a	Industrial Management	3
M. E. 215	Locomotive Operation	4
M. E. 216	Locomotive Design	8
G. E. 202	Contracts and Specifications	3
E. E. 122a	Electric Railway Engineering	5
G. E. 301	Ethics	2

*Note: Railway Mechanical Engineering may be substituted in place of Industrial Engineering or Steam and Gas Engineering.

*FIFTH YEAR.—STEAM AND GAS ENGINEERING.**

M. E. 204	Gas Engines	3
M. E. 213	Steam Turbines	2
M. E. 102	Gas Engine Design	8
M. E. 207	Power Plants	7
E. E. 114	Electrical Station Practice	2
C-7	Coordination and English	2

Second Term		Hours Per Wk.
M. E. 207a	Power Plants	5
M. E. 206	Heating and Ventilating	6
M. E. 212	Air Compressors and Refrig. Machs	4
M. E. 103	Advanced Machine Design	4
E. E. 120	Power Distribution	2
G. E. 202	Contracts and Specifications	3
G. E. 301	Ethics	2

*Note: Steam and Gas Engineering may be substituted in place of Industrial Engineering or Railway Mechanical Engineering.

DESCRIPTION OF COURSES

GENERAL ENGINEERING GROUP

G. E. 101.—Elementary Engineering. *Four hours per week in laboratory.* This course is especially designed to give the freshman a general idea of engineering machines, equipment, methods and purposes of laboratory work.

G. E. 201.—Economics . *Three hours recitation per week.* A study of the general principles of economics especially as it relates to engineering problems and activities.

G. E. 202.—Business Organization. *Two hours recitation per week.* This course shows the importance of organization in business and the tendencies of modern industrial development. The organization of certain businesses is studied to illustrate the principles.

G. E. 203.—Contracts and Specifications. *Three hours recitation per week.* A study of the importance and requirements of engineering contracts and specifications.

G. E. 301.—Ethics. *Two hours per week.* Goal of human activity, norm of morality; law, its sanction and source; rights and duties; professional ethics, etc.

COORDINATION

C1, 2, 3, 4, 5, 6, 7, 8 and 9. *Two hours per week each. The assignment of practical engineering problems to be solved largely by observation aid study during the students' work period at the shops.* This includes many written reports which are passed upon by both the English and Engineering Departments. It also includes participation in the regular meeting of the Engineering Association.

The latter organization has both a cultural and social end in view. It professes to train the young engineers under competent direction to fluency, ease and proficiency in public speaking. At the same time it affords an outlet for the social activities of its members.

CHEMICAL ENGINEERING COURSES

Ch. E. 100—Metalurgy of Iron and Steel. *Three class hours per week.* A study of the sources of raw material, methods of obtaining the ore and the various processes of producing steel; rolling mill and foundry practice; the properties of special steels and their application to industry.

Ch. E. 102.—Metallography. *Four hours per week in laboratory with lectures. Must be preceded by Course 100.* This course consists of the microscopic examination of metals and alloys with the special reference to the effects of heat treatment of steel.

Ch. E. 104.—Heat Treatment of Steel. *Two class hours per week and four laboratory hours.* Must be preceded by Course 100. A laboratory study of modern methods in heat treatment of steel. Purposes of heat treating methods of temperature control, design of furnaces, annealing, hardening, tempering and case hardening.

Ch. E. 200.—Technical Pyrometry. *Four hours per week.* Laboratory study of high temperature measurements, calibration of thermo-couples, resistance pyrometers and the use of these instruments in industry.

Ch. E. 201.—Quantitative Inorganic Technical Analysis. *Eight laboratory hours per week.* The technical methods of quantitative analysis of limestone and cement for silica, iron and aluminum oxides, magnesia, lime, alkalies, anhydrous sulphuric acid and total sulphur. Methods for the quantitative analysis of allays for copper, zinc, tin, lead, iron, aluminum, and antimony.

Ch. E. 202.—Quantitative Organic Technical Analysis. The determination of the physical and chemical constants of mineral, vegetable and animal oils; density; flash and burning points, viscosity, melting points; acid value; saponification value; iodine value; Reichert Meissl value and color tests with acids, quantity extraction of oil and fats; their identification and application to soap industry. The analysis of soaps and tanning materials.

Ch. E. 204.—Applied Thermal Chemistry. *Three lectures per week.* Investigation of chemical reactions which take place at high temperatures.

Ch. E. 206.—Applied Electro Chemistry. *Two lectures and one four hour laboratory period.* The application of the principles of electro chemical and electro thermal reactions to the decomposition of compounds, electro plating and electro quantitative chemical analysis.

Cr. E. 207.—Industrial Chemistry. *Lectures, written reports and inspection trips.* A study of industrial processes of chemical manufacture.

Ch. E. 208.—Assaying. *Four laboratory hours per week.* The quantitative analysis of ores for their mineral content. Fire assay for gold and silver.

Ch. E. 209. Fuel and Gas Analysis. *Twelve laboratory hours per week.* Analysis of coal and coke. Determination of moisture, volatile matter, fixed carbon, sulphur, ash, and caorlimeter determination of calorific value. Analysis of gases for carbon dioxide, oxygen; carbon monoxide, hydrocarbons, hydrogen and nitrogen by means of Hempels' apparatus. The application of the Orsat apparatus to the analysis of flue gases.

Ch. 1. 210.—Iron and Steel Analysis. *Four laboratory hours per week.* Determination of manganese, sulphur, phosphorous, carbon, chromium, vanodium and nickel content of iron, plain and alloy steels.

Ch. E. 211.—Water Analysis. (Industrial). The analysis of water for total solids, chlorides, silica, magnesia, lime, iron and aluminum oxides; hardness, temporary and permanent; fitness for boiler and other industrial uses. The softening of water.

Ch. E. 212.—Water Analysis (Sanitary). The analysis of potable waters, and tests of the methods of sewage purifications, including tests for sesidue; chlorides; nitrogen as ammonia, free and albuminoid; nitrogen as nitrates; nitrogen as nitrites; oxygen consumed for oxidation or organic matter; dissolved oxygen, and metallic impurities. This course also includes the bacterial count and determination of the presence or absence of the bacteria of the colon group.

CIVIL ENGINEERING COURSES

TOPOGRAPHICAL GROUP.

C. E. 101.—Elementary Plane Surveying. *One hour recitation and two hours field work per week. Prerequisites, Math. 6, and Engineering Drawing 1.* Work covers theory and use of range poles, tape and compass and the use and adjustment of the level. Notes, maps and reports are required. Pacing, chaining, compass surveys, differential, profile and contour leveling are included in the field work.

C. E. 101a.—Elementary Plane Surveying. *One hour recitation and two hours field work per week. Prerequisites, Math. 6 and Drawing 1.* A special condensed course in the use and adjustments of instruments for Mechanical and Chemical students.

C. E. 102.—Elementary Plane Surveying. *Two hours recitation and ten hours field work per week in summer term.* Continuation of Course 101.

C. E. 102a.—Elementary Plane Surveying. *Two hours recitation and ten hours field work per week in Summer term.* Continuation of C. E. 101a.

C. E. 103.—Plane Surveying. *One hour recitation and two hours field work per week. Prerequisites, C. E. 101, and C. E. 102.* Takes up the use and adjustment of the transit and plane table, measurement of angles, transit and plane table surveys by tape and stadia methods.

C. E. 104.—Plane Surveying. *Four hours recitation and sixteen hours field work per week in summer term.* Continuation of C. E. 103. Also, a study is made of the principles and practice of land and city sureyving.

C. E. 104a—Plane Surveying. *Four hours recitation, six hours field work per week during summer term.* This is continuation of C. E. 103 for Electricals.

C. E. 105.—Topographic Surveying. *One hour recitation and two hours field work per week. Prerequisites, C. E. 103, and C. E. 104.* Study is made of the theory and practice of surveying as applied to topographic work and includes base line measurement, triangulation, barometric and precise leveling, etc.

C. E. 106—Topographic Surveying. *Three hours recitation and six hours field work. Continuation of C. E. 105.* In the field a topographic survey is made and calculations and map showing same are required.

RAILWAY GROUP.

C. E. 201.—Railroad Curves. *Three hours recitation per week. Prerequisites, C. E. 105 and C. E. 104.* Study of simple, compound, reverse and spiral curves, turnouts and crossovers.

C. E. 202—Railroad Location. *Five hours recitation and fifteen hours field work per week during the summer term. Prerequisite, C. E. 201.* Theory and practice of railroad location including reconnaisance and preliminary surveys, paper and final locations, developed by both class and field work. Mapping and office work is included.

C. E. 203.—Railroad Location. *Six hours field and office work per week.* Continuation of Course 202. Cross-sectioning, estimating quantities from center line profile and construction of mass diagram.

C. E. 204.—Railroad Construction *and* Maintenance. *Four hours recitation per week. Prerequisite, C. E. 201.* Study is made of the methods of calculation of earthwork and the theory of frogs and switches, maintenance of way, structures and appliances.

C. E. 205.—Railroad Location and Construction. *Seven and one-half hours field work per week during the summer term. Prerequisite, C. E. 204.* Calculation of earthwork and estimate of quantities in connection with given problems.

C. E. 206.—Railroad Terminals. *Three hours recitation per week. Prerequisite, C. E. 204.* Study is made of railroad terminals and yard layouts together with structures and appliances in connection therewith.

STRUCTURAL GROUP.

C. E. 301.—Theory of Structures. *Six hours recitation per week. Prerequisite, Mech. 102.* Study of determination by both analytical and graphical methods of the stresses in various types of roof and bridge trusses.

C. E. 302.—Structural Design. *Eight hours per week in drafting room. Prerequisite, C. E. 301.* In this course each student is given a different set of conditions under which he designs completely wooden and steel roof trusses.

C. E. 303.—Structural Design. *Ten hours per week in drafting room, during Summer term. Prerequisite, C. E. 301.* Complete design is made of railroad plate girder bridge.

C. E. 304.—Bridge Design. *Twelve hours per week in drafting room. Prerequisite, C. E. 303.* Each student is required to make a complete design of a pin connected railroad bridge.

C. E. 305.—Structural Design. *Fifteen hours per week in drafting room during Summer term. Prerequisite, Mech. 104.* A course in the design of steel buildings especially arranged for Mechanical and Electrical Engineering students.

C. E. 306.—Bridge Engineering. *Three hours recitation per week. Prerequisite, C. E. 301.* This course takes up stresses in statically indeterminate structures as well as the definition of structures and the determination of the true stresses in redundant members. Both graphic and analytic methods are used.

C. E. 307.—Advanced Bridge Design. *Six hours per week in the drafting room. Prerequisite, C. E. 306.* This course consists of the design of a swing bridge.

C. E. 350.—Masonry Construction. *Three hours recitation per week. Prerequisite, Mech. 104.* A study of the principles and design of various types of masonry structures and the materials used therein.

C. E. 351.—Principles of Reinforced Concrete. *Two hours recitation per week. Prerequisites, C. E. 301, and Mech. 104.* The theory of structures as applied to reinforced concrete design. Analysis and problems in design and construction.

C. E. 352.—Principles of Reinforced Concrete. *Two and one-half hours recitation and seven and one-half hours drafting per week.* Continuation of C. E. 351.

C. E. 353.—Reinforced Concrete. *Three hours recitation per week. Prerequisites, C. E. 351, and C. E. 352.* A study of reinforced concrete as applied to building design.

C. E. 354.—Reinforced Concrete Design. *Six hours per week in drafting room.* A study is made of the various types of reinforced concrete construction. Complete design is made of reinforced concrete building.

C. E. 355.—Concrete Arches. *Six hours per week in drafting room. Prerequisite, C. E. 356.* This course consists of a series of lectures and design periods. The lectures apply the principles of statically indeterminate structures to concrete arches. The actual design of a concrete arch is made.

C. E. 356.—Foundations. *Two hours recitation per week. Prerequisite, Mech. 104.* A study of the principles and design of various types of foundations.

MUNICIPAL AND HYDRAULIC GROUP.

C. E. 401.—Highways. *Three hours per week recitation. Prerequisite, C. E. 201.* Design, construction and maintenance of highways and streets. The various types of pavements are studied.

C. E. 402.—Public Water Supply. *Three hours per week recitation. Prerequisite, Mech. 201.* Study of the principle features of water works design and construction including quantity and quality of potable water, sources of supply, design of distribution systems, reservoirs, dams and tanks.

C. E. 403.—Sewerage. *Two hours per week recitation. Prerequisite, Mech. 201* Study of the design and construction of sewerage systems including surveys and estimates, determination of size and capacity of sewers and the various methods of sewerage disposal.

C. E. 404.—Irrigation and Drainage. *Two hours per week recitation. Prerequisite, Mech. 201.* A study of the principles of irrigation engineering including various methods and means of irrigating and the design and construction of reservoirs, canals, flumes and other irrigation works. Also, the principles involved in the reclamation of land by drainage.

C. E. 405.—Water Power Engineering. *Three hours per week recitation. Prerequisite, Mech. 201.* A study of the principles involved in the consideration of a water power project such as the effects of variation of flow, head, etc., types, characteristics, selection and installation of water wheels.

ELECTRICAL ENGINEERING COURSES

E. E. 102.—Electricity and Magnetism. *Five hours per week in class-room. Prerequisite, Physics 107, and Math. 9.* This covers a fundamental theory of steady current circuits—Ohm's Law, Kirchhoff's Law, calculation of magnetic fields due to currents—forces on currents in magnetic field, generation of E. M. F.—Electric power and instruments.

E. E. 103.—Electrical Laboratory. *Ten hours per week in laboratory during Summer term.* Prerequisites, Physics 107 and E. E. 102. This is an experimental study of the work covered in E. E. 102 and E. E. 104. The student first takes up the practical operation of motors and generators after which the commercial methods of testing direct current apparatus is studied.

E. E. 104.—Direct Current Machines. *Five hours per week in class-room during summer term. Prerequisite E. E. 102.* This work is a continuation of 102 taking up the study of direct-current dynamo theory including the operating characteristics.

E. E. 106.—Direct Current Problems. *Three hours per week in class-room. Prerequisite, E. E. 104.* Different types of windings, for direct current machines, are discussed and the student is required to make the calculations and drawings of windings for numerous kinds of machines. Advanced problems in electricity and magnetism are given one hour per week throughout the term.

E. E. 107.—Electrical Laboratory. *Six hours per week in laboratory. Prerequisites, E. E. 103 and E. E. 104.* This is a continuation of E. E. 103 in which the experimental study of the characteristics of direct current generators and motors is made in detail.

E. E. 107a.—Electrical Laboratory. *Four hours per week in laboratory for five weeks. Prerequisites E. E. 106 and E. E. 107.* This is a continuation of Course E. E. 107.

E. E. 108.—Alternating Currents. *Five hours per week in class-room. Prerequisite, E. E. 106.* This work begins with a physical and mathematical study of the effect of the various quantities in alternating current circuits. The general plan is to convey first a mental conception of the different relations and then to show how these relations may be expressed mathematically and graphically. The symbolic method is also studied. Practical problems are given to illustrate the use of the different methods and to familiarize the student with practical applications of alternating currents. This includes a study of polyphase alternating currents.

E. E. 109.—Electrical Design. *Four hours per week in drawing room. Prerequisites, E. E. 106 and Drawing 3.* The calculations in

the design of direct current machinery are first considered by studying in detail, the design of various types and sizes of machines, then the derivations of the equations after which the student is required to make the calculations and detail drawings for a specified machine.

E. E. 110.—Alternating Current Machinery. *Five hours per week in class-room. Prerequisite, E. E. 108.* The mathematical and graphical methods are next applied to the study of alternating current machines, beginning with the transformer, then taking up in logical sequence the induction motor; alternators; converters; commutator types of alternating current motors; insulations; corona; short transmission lines and regulation by power factor. The operating characteristics and practical applications of these machines are studied and the characteristics of the different apparatus are taken up to show their special fitness for the various classes of service they are required to perform.

E. E. 110a.—Alternating Current Machinery. *Five hours per week in class room. Prerequisite, E. E. 110.* This is a continuation of Course E. E. 110.

E. E. 111.—Electrical Laboratory. *Four hours per week in laboratory for five weeks. Prerequisites, E. E. 107 and E. E. 108.* This is an experimental study of alternating current circuits involving combinations of resistance, inductive reactance and capacity reactance in series and parallel circuits, after which the study of transformers and alternators are taken up in detail.

E. E. 111a.—Electrical Laboratory. *Ten hours per week in laboratory during summer term. Prerequisites, E. E. 111 and E. E. 108.* This is a continuation of Course E. E. 111.

E. E. 112.—Alternating Current Problems. *Three hours per week in class-room. Prerequisite, E. E. 110a.* Two hours per week are devoted to transmission and distribution of electrical energy including a study of materials used, appliances—development of formulæ for preliminary and exact calculations of transmission lines and performance computations for long distance transmission lines. One hour per week being devoted to advanced problems.

E. E. 113.—Electrical Laboratory. *Six hours per week in laboratory. Prerequisites, E. E. 110 and E. E. 111a.* This is a continuation of Course 111 and includes converters, and alternating current motors.

E. E. 114.—Electrical Station Practice. *Two hours per week in class-room. Prerequisite, E. E. 110.* The operation of central station and sub-station apparatus is taken up and studied both in regard to economy of operation and to methods of manipulation.

E. E. 115.—Electrical Design. *Four hours per week in drawing room. Prerequisites, E. E. 109, and E. E. 110.* A course similar to 109 with the exception of considering alternating current machinery instead of direct current machinery.

E. E. 116.—Telephone Engineering. *Two hours per week class and three hours per week laboratory. Prerequisite, E. E. 106.* This course includes a detailed study in class of the fundamental principles and construction of modern telephone equipment and circuits for all classes of service. Wireless telegraphy and telegraph instruments and systems are studied briefly in the latter part of the course.

The class work is accompanied by an individual study of the apparatus and its connections, in the laboratory, and by visits to manufacturing and operating centers in the city.

E. E. 116a.—Telephone Engineering. *Two hours per week in class-room and three hours per week in laboratory or inspection trips. Prerequisite, E. E. 116.* This is a continuation of Course E. E. 116.

E. E. 117.—Electrical Laboratory. *Four hours per week in laboratory. Prerequisites, E. E. 110, and E. E. 113.* This is an advanced laboratory course in which research work on some special subject or piece of apparatus is conducted.

E. E. 118.—Illumination and Photometry. *Two class hours per week, three laboratory hours. Prerequisite, E. E. 108.* A consideration of light, standards of light and photometry, illuminants of combustion, incandescent lamps and arc lamps, shades and reflectors, and illumination of residences, large interiors and streets.

This course is supplemented by laboratory work involving the investigation of the accuracy and sensibility of photometric devices, manipulation and use of photometers, investigation of the illumination of and reflection from walls and ceiling, study of the direct, semi-direct and indirect lighting systems, and the efficiency of different classes of reflectors.

E. E. 118a.—Illumination and Photometry. *Two hours per week in class-room and three hours per week in laboratory. Prerequisite, E. E. 118.* This is a continuation of Course E. E. 118.

E. E. 119.—Central Station Design. *Four hours per week in drawing room. Prerequisites, E. E. 110, and Drawing 3.* An extended study is made of the various appliances used in the equipment of a modern power plant. The instruction is given chiefly at the drafting board. The work is conducted in such a way that the student may meet and overcome the numerous problems that arise in actual engineering practice. Each student is given, as a problem, the design of an electric lighting or street railway power station to fulfil certain given conditions. In this way the student becomes familiar with the

fundamental details and considerations affecting electric station design.

E. E. 120.—Power Distribution. *Two class hours per week. Prerequisite, E. E. 110.* A study of the principles and layouts of direct and alternating current distribution for light and power purposes, methods of installation and regulation of typical circuits for above are studied and the student is required to design one complete layout from data given him.

E. E. 122.—Electrical Railway Engineering. *Three class hours per week during first term. Prerequisite, E. E. 110.* This course treats of the design, construction, and operation of electric railways, from the preliminary field engineering to the final calculations of income and operating expenses. This includes a treatment of preliminary survey of the region considered, speed—time—energy—curves, motor characteristics, schedules; choice of motor, acceleration, and character of system; load curves, generating station, sub-station, distributing system, construction and operation of the road; and the financial items involved. A typical design is carried through to illustrate the methods actually employed in the design of a high speed interurban system.

In addition to the lectures the student will devote three hours per week to the design of a particular system, starting from data on the nature of the proposed road, character of the business, etc., and will work out the electrical equipment completely.

E. E. 122a.—*Electrical Railway Engineering. Two hours per week in class room and three hours per week in drawing room. Prerequisite E. E.* 122. This is a continuation of Course E. E. 122.

E. E. 124—Secondary Cells. *Two class hours per week. Prerequisite, E. E. 104.* A description of cells and their mode of employment; setting up cells; charging, and discharging; storage capacity and efficiency of various cells; failures—their causes and remedies; maintenance and care; testing and their application to central station work and power distribution.

E. E. 126.—Transformer Practice. *Two class hours per week. Prerequisite, E. E. 110.* This course takes up the operation of transformers from the practical standpoint and includes the selection of transformers for various purposes and methods of connecting them for phase transformation, etc.

THE FOLLOWING COURSES ARE OPEN TO STUDENTS FROM OTHER DEPARTMENTS:

E. E. 130.—Direct Currents. *Three class hours per week. Prerequisites, Math. 9, and Physics 3a.* The work covered in this course

includes part of Courses 102, 104 and 106, leaving out the more mathematical considerations. The laws of the electric and magnetic circuits are applied to explain the operation of such electrical measuring instruments as are used commercially.

E. E. 131.—Electrical Laboratory. *Four hours per week in laboratory for five weeks. Prerequisite, E. E. 130.* The important operating characteristics of generators and motors are obtained experimentally, the purpose being to show the difference between types of machinss and to give the student a knowledge of the erection and operation of such machines.

E. E. 131a.—Electrical Laboratory. *Four hours per week in laboratory. Prerequisites, E. E. 131, and E. E. 132.* This is a continuation of E. E. 131.

E. E. 132.—Direct Current Machinery. *Six class hours per week during summer term. Prerequisites, E. E. 130.* This is a continuation of Course 130 and develops the theory of direct current machines, generators, and motors especially, with a view to familiarize the student with the various types of machines, the difference of design, and the effect of these differences on operation, without working out the rules governing design. Special attention is given to motors regarding speed variation and applicability to various purposes.

E. E. 134.—Alternating Currents and Alternating Current Machinery. *Five class hours per week. Prerequisite, E. E. 132.* Some time is given to the development of the theory of the alternating current circuit. A discussion of the theory of commercial alternating current machinery follows. As in 132 the effort is to make clear the differences in construction, operation, and availability of the various types of alternators, transformers and motors. All working formulae for design are omitted.

E. E. 135.—Electrical Laboratory. *Four hours per week in laboratory for five weeks. Prerequisites, E. E. 131a and E. E. 134.* After introducing experiments on alternating current circuits, others on generators, transformers, and motors follow. These experiments are to show the characteristics of the various machines and to familiarize the student with connecting and operating them.

E. E. 135a.—Electrical Laboratory. *Ten hours per week in laboratory for four weeks. Prerejuisites, E. E. 134 and E. E. 135.* This is a continuation of E. E. 135.

E. E. 136.—Elements of Direct Currents and Direct Current Machinery. *Three class hours per week. Prerequisites, Math. 9 and Physics 3.* The work covered includes a brief study of electric

and magnetic circuits; the operation and use of those electrical instruments used in the measurement of resistance, current, potential, power and energy; the theory and principles of construction and operation of direct current motors and generators and their auxiliary equipment.

E. E. 137.—Electrical Laboratory. *Four hours per week in laboratory.* This course is the laboratory accompaniment to Course 136.

E. E. 138.—Elements of Alternating Currents and Alternating Current Machinery. *Three class hours per week. Prerequisite, E. E. 136.* This course includes a brief study of the principles of alternating current and the principles of construction and operation of alternating current motors and alternators and their auxiliary equipment.

E. E. 139.—Electrical Laboratory. *Four hours per week in laboratory. Prerequisite, E. E. 137.* This is an experimental study of the principles covered in Coarse 138 and is given parallel with it.

MECHANICAL ENGINEERING COURSES

MACHINE DESIGN GROUP.

M. E. 100.—Mechanism. *Two class hours per week. Four hours per week in drafting room. Must be preceded by Math. 7 and Drawing 2.* A systematic study is made of velocity diagrams and of the various forms of motion occuring in machines. A considerable part of the time is devoted to the design of cams and gears.

M. E. 101.—Machine Design. *Four hours per week in drafting room. Must be preceded by Course 100 and Mech. 106 and 104.* This is a continuation of Course 100 with the application of mechanics necessary for determining the strength of machine parts. Each student is required to complete the design of some simple machine.

M. E. 102.—Steam and Gas Engine Design. *Eight hours per week in drafting room. Must be preceded by Courses 101, 200 and 201.* This is essentially a course in design supplemented with lectures on the methods employed in determining the more important details of steam and gas engines.

Problems are assigned requiring the application of thermodynamic principles as well as the use of emperical formulæ.

M. E. 103.—Advanced Machine Design. *Four hours per week in drafting room. Must be preceded by Course 102.* Lectures and drafting room work, dealing with the study of inertia forces that arise in various kinds of machinery, especially where high speeds are

employed, and the methods of balancing these forces. This includes investigation of governors, dynamo armatures, centrifugal machines, the gyroscope and its applications, and the balancing of multicylinder engines.

M. E. 104.—Machine Design. *Two hours class per week, four hours per week in the drafting room.* Lectures and drafting room work, dealing with the principles of machine design particularly of apparatus employed in chemical manufacture.

STEAM AND GAS ENGINEERING GROUP.

M. E. 200.—Applied Thermodynamics. *Five class hours per week. Must be preceded by Mech. 1, Physics 3, Chem. 2.* This course embraces a detailed study of the elementary principles of thermodynamics, properties of steam, calorimeters, steam pumps, stokers and furnaces, feed-water heaters, superheaters, fuels and combustion.

M. E. 201.—Heat Engines. *Four class hours per week.* A continuation of Course 200 including a study of the principles underlying the simple and multiple expansion steam engine, the Carnot and Rankine Cycles, the indicator diagram, and various governing devices for reciprocating engines.

M. E. 201a.—Heat Engines. *Three hours per week during the Summer term.* Continuation of Course 201. Prerequisite, Course 201.

M. E. 202.—Mechanical Laboratory. *Four hours per week in laboratory. Must be preceded by Mechanics 102, Physics 3, Chemistry 2.* This course runs parallel with Course 200. It includes the calibration of pressure gauges, thermometers, meters, etc., practice in the use of the steam engine indicator. It is intended to familiarize the student with mechanical laboratory instruments.

M. E. 203.—Mechanical Laboratory. *Four hours per week in laboratory. Must be preceded by Course 202.* This is a continuation of Course 202 including steam calorimeter tests, analysis of flue gases, flow of steam through orifices, steam engine valve setting, and mechanical efficiency tests of steam and gas engines.

M. E. 204.—Gas Engines. *Three class hours per week. Must be preceded by Course 201.* A study of the internal combustion engine based on theory and practice. The various types of engines are studied with particular attention to the fuels used, carbureting ignition, governing, lubrication, timing of valves, and general operating conditions. The course includes a study of recent developments in the design of Diesel and other engines.

M. E. 205.—Mechanical Laboratory. *Four hours per week in laboratory. Must be preceded by Course 204.* Evaporative tests of boilers, steam consumption, and power development of an electrical plant, tests of air compressors, steam pumps and injectors, the determination of efficiencies, losses, and characteristics of gas and oil engines.

M. E. 206.—Heating and Ventilating. *One class hour per week. Three hours per week in drafting room.* Direct and indirect steam and hot water heating, gravity systems, vacuum systems, direct air heating, ventilating, temperature and humidity control, heating boilers and furnaces. The course includes a complete layout of a heating and ventilating system for a typical building.

M. E. 207.—Power Plant. *Seven hours per week. Drafting room supplemented with lectures.* This course includes a discussion of the mechanical problems involved in the selection of power plant units, including auxiliary equipment. Each student is required to select and arrange a complete plant equipment.

M. E. 207a.—Power Plants. *Five hours per week.* A continuation of Course M. E. 207 which includes a more detailed study of power plant equipment, location, design and economy.

M. E. 208.—Compressed Air. *Two class hours per week for one term. Must be preceded by Course 201.* A mathematical treatment of the problems entering into the production, transmission, and application of compressed air. A study is made of the air compressor with particular reference to the effect of clearance, methods of cooling, advantages of compounding, etc. Attention is given to the hydraulic compressor, measurement of air, friction of air in pipes, and the air lift.

M. E. 209.—Refrigeration. *Two class hours per week for one term. Must be preceded by Course 201.* This course is designed to give the student a working knowledge of the problems entering into the selection of a mechanical refrigeration plant and includes a complete description of the various types of commercial ice machines and systems of refrigeration.

M. E. 210.—Engines and Boilers. *Two class hours per week. Must be preceded by Physics 3, Mathematics 8.* An abridged course for civil engineers consisting of lectures and recitations on the operating principles of steam engines, boilers, and steam power plant auxiliaries.

M. E. 211.—Mechanical Laboratory. *Four hours per week in laboratory. Must be preceded by Course 210.* A special course for civil engineers which includes the operation of steam and gas engines and commercial methods of testing engines and boilers.

M. E. 212.—Air Compressors and Refrigerating Machines. *Four class hours per week.* This course purposes to deal jointly with the construction, operation and maintenance of air compressors and refrigeration machinery.

M. E. 213.—Steam Turbines. *Two hours per week for one term. Must be preceded by Course 201.* The thermodynamic principles underlying the design of steam turbines and the discussion of various types, their adaptability for different classes of service, and a comparison with the reciprocating engine.

M. E. 214.—Railway Mechanical Engineering. *Three class hours per week.* This course includes in its scope the design and construction of locomotives and cars; interchange of parts; car lighting and heating; maintenance of railway equipment; terminals; classification and operating statistics.

M. E. 215.—Locomotive Operation. *Four class hours per week.* This course deals with the mechanical performance of the locomotive —rate of combustion, draft, boiler efficiency, steam distribution in the cylinder, variations of power with speed, superheaters, economizers, and other important apparatus affecting the performance of the modern locomotive.

M. E. 216.—Locomotive Design. *Eight hours per week in drafting room.* A study of the principles underlying the design and construction of the locomotive. The engine with its parts, valves, piston, cylinder, cross-head, connecting rods, valve gears and the steam generating plant are gone into separately.

INDUSTRIAL ENGINEERING GROUP.

M. E. 301.—Principles of Accounting. *Three hours per week.* Elements of accounting; single and double entry; debits and credits; journalizing; posting and trial balances; closing books; proprietors' accounts; partnership accounts, etc.

M. E. 301a.—Principles of Accounting. *Three hours per week.* Advanced accounting; analytic study of the balance sheet; assets and liabilities; depreciation; capital stock; profits; surplus reserves; sinking funds; counting house methods, etc.

M. E. 302.—Commercial Law. *Three hours per week.* Contracts; negotiable instruments; agency; partnership; corporations.

M. E. 302a.—Commercial Law. *Three hours per week.* Sales; bailments; carriers; guaranty and suretyship; insurance; real property and tenancy.

M. E. 303.—Industrial Management. *Five lectures or recitations*

per week. The various methods of control of industry; cost accounting; distribution of expense; purchasing; sales organization.

M. E. 303a.—Industrial Management. *Three lectures or recitations per week.* A continuation of M. E. 303 which includes discussion of labor problems! welfare work; safety and sanitation.

M. E. 304.—Production Engineering. *Three class hours per week.* A detailed study of problems involved in shop management such as routing of products; time study and bonus systems; depreciation of equipment; stock records; inspection systems; safety devices and the human element in production.

M. E. 304a.—Production Engineering. *Three or four hours per week.* A continuation of M. E. 304 which includes numerous inspection trips and the written reports on shop processes and equipment.

M. E. 305.—Credits and Collections. *Three hours per week.* Forms of credit; classes of credit and credit machinery; duties and qualifications of the credit man; elements determining the credit risk; sources of credit; information; the financial statement; legal remedies of the creditor; extensions, compositions and adjustments; bankruptcy; insolvency and receivership; credit safeguards.

M. E. 306.—Corporation Finance. *Four hours per week.* A study of the organization and financial management of corporations including business promotion; principles of catipalization; means of financing an organization; determination of profits; valuation of securities; methods of consolidation; reorganization of corporations.

M. E. 307.—Business Correspondence. *Two hours per week.* The principles underlying every form of business; English; general correspondence; sales letters; follow-up letters; circulars; reports, etc.

M. E. 308.—American Government. *Four class hours per week.* A study of the development and practical working of our federal, state, and local governments.

M. E. 309.—Advertising. *Three hours per week.* Psychology of appeal; color; laws of memory; inducing action; analysis of successful advertisements; the advertising agency, etc.

M. E. 310.—Practical Salesmanship and Sales Administration. *Three hours per week.* Personal qualifications; tact; address and their development; a study of the elements that make for success; knowledge of the goods to be sold; studying the prospective buyer; approach, demonstration, presentation of argument; closing the sale, etc.

GENERAL COURSES

ACCOUNTING.

COURSE I. General Accounting. I, II; (2).
COURSE II. Corporation Accounting. I, II; (2).
COURSE IV. Cost Accounting.

These courses are offered in the College of Economics, but are open also to the students of the Engineering Department.

ASTRONOMY.

Young's Astronomy—historical, descriptive and practical. Lectures and recitations. For reference, Clerk's History of Astronomy, Newcombs "The Stars"; Lockyear, Langley.

CHEMISTRY.

Chem. 1.—Inorganic Chemistry. *Two lectures, one recitation, and two hour laboratory periods.* The study of elements, compounds, chemical combinations, and the fundamental laws of chemical combinations. The atomic and molecular theory. Atomic weights and calculation of chemical formula; equivalence; volence; laws of Charles, Boyle and Avogadro; Gay Lussac's law of combining volumes; development, the chemical formula; solutions; freezing point depression of solutions; osmatic pressure; chemical equilibrium; dissociation of solution; ionic substances an dtheir interactions; nonmetallic elements and their compounds.

Chem. 2.—Inorganic Chemistry. *Two lectures, one recitation, and two two-hour laboratory periods.* Review of chemical theories and continuation of the study of chemical elements and their compounds; supplemented by chemical problems.

Chem. 3.—Qualitative Chemical Analysis. *Twelve laboratory hours, Summer term.* The chemistry of the metallic elements and their compounds.; the application of chemical theory to the formation of insoluble compounds; the separation of bases and acids; the solution and analysis of alloys, ores, and inorganic elements or compounds in the presence of organic matter.

Chem. 5.—Quantitative Chemical Analysis.—Gravimetric. *Two two-hour laboratory and class room periods.* Through individual laboratory instructions stress is laid upon care and accuracy. This course is devoted to the grovimetric method of determination. This includes the types, use and care of analytical balances, a selected number of gravimetric determinations of basic and acid constituents to illustrate the different conditions of precipitation, washing, drying, decomposition and weighing of precipitates.

Chem. 5a.—Quantitative Chemical Analysis.—Volumetric. *Two two-hour laboratory and class room periods.* The use and calibration volumetric apparatus. Selection and use of indicators; preparation and standardization of valumetric solutions. A selected number of acidimetric(alkalimetric, oxidimetric and precipitation determinations.

Chem. 6.—Organic Chemistry. *Two lectures and one four-hour laboratory period.* The apparatus and chemical operations involved in organic synthsis. Determination of the purity of compounds, their qualitative analysis, and the general principles and theories of organic chemistry; physical and chemical properties of the compounds of the open chain series.

Chem. 6a.—Organic Chemistry. *Two lectures and one four-hour laboratory period.* This course is a continuation of Course 6. Physical and chemical properties of the closed chain series.

Chem. 7.—Physical Chemistry. *Two lectures and one four-hour laboratory period.* The physico-chemical relations. The general principles of chemistry are studied and closely correlated with the laboratory work. Gas densities and relation to molecular weights, conductance of electricity in solution, the theory of the ion, mass action applied to equilibrium, freezing point depression and boiling point elevation of solutions.

DRAWING.

Drawing 1.—Elementary Drawing. *Four hours drawing-room work during first term. Required of all Engineers.* The course consists of practice in the use of instruments, practice in lettering and elementary orthographic projections.

Drawing 2.—Elementary Drawing. *Four hours drawing-room work during second term. Prerequisite, Drawing 1. Required of all Engineers.* This course consists of lettering, orthographic and oblique projections.

Drawing 3.—Advanced Drawing. *Ten hours drawing-room work during Summer term. Prerequisite, Drawing 2.* This is a course of technical sketching, isometric and cabinet projections.

Drawing 4.—Descriptive Geometry. *One lecture and recitation hour and four hours drawing-room work during first term.* This is a study of orthographic projections as applied to the solution of problems involving the point, line and plane; the representation of curved and warped surfaces; and the intersections and developments. Many problems are assigned for home work.

ENGLISH.

English 1.—*Three class hours per week.* The object of this course is to fit the future engineer for the use of English most called for in his life work. Therefore, while other forms of expression are not neglected, chief stress is laid on exposition both oral and written. The great need of the engineer is to be able to express his ideas clearly, cogently, and effectively.

Daily exercises are given in written and oral exposition as a regular part of the class work. Besides the criticism of the professor, the members of the class are called upon to offer their opinions of each exercise.

English 2.—*Three class hours per week.* Continuation of Course 1. In addition to this, papers on physical, chemical, and electrical topics submitted to professors of other departments will be criticized from the viewpoint of correct and idiomatic English.

GEOLOGY.

General course in dynamic, structural, physiographic, historical, and economic geology. Principles of petrology, mineralogy and paleontology. Study of the field work of the Wisconsin Geological Survey. The College possesses a collection of the more important minerals and rocks; in addition to this the students have access to the Public Museum, the entire third floor of which is devoted to geology.

Lectures, field work, identification of life forms, recitations and written exercises. Text: *Le Conte:* Salisbury and Chamberlain. For reference: The extremely valuable publications of the Wisconsin Geological Survey and the United States Geological Surveys Monographs and Bulletins.

MATHEMATICS.

Math. 5.—Advanced Algebra. *Six class hours per week.* A brief but thorough review of the foundations is given (negative and irrational numbers, indices, fractions, graphic and analytic discussion of linear and quadratic equations), after which the following topics are treated: determinants, logarithms, complex numbers, solution of higher equations, introduction to series, convergence-tests, undetermined coefficients.

Math. 6.—Trigonometry. *Six class hours per week, first part of term.* The elementary functions, their relations, their graphs; functions of sums, differences and multiples of angles; solutions of all cases of plane and spherical triangles; solution of pure and mixed trigonometrical equations by graphic methods. Emphasis is laid on the practical use of formulas, rather than on their derivation.

Math. 7.—Analytical Geometry. *Six class hours per week last part of term.* A thorough study of graphic methods precedes this course, after which the line, the individual conics, and the general conic are treated with sufficient completeness. The spirit and methods of analytic geometry are emphasized, and illustrations are drawn from transcendental and higher algebraic curves whenever possible. The essentials of solid geometry are given.

COURSE 7a.—Analytic Geometry. *Six class hours per week for first six weeks.* Continuation of Course 7.

Math. 8.—Differential and Integral Calculus. *Six class hours per week for last four weeks.* The fundamental formulas and processes of differentiation are followed by applications to maxima and minima, inflexions, envelopes and evolutes; integration, both formal and as a summation, follows at once, with applications to curves, surfaces, and volumes. A close connection with the classes in Mechanics will be maintained, so that certain types of differential equations will be taken up as soon as possible. Taylor's Theorem and the subject of series in general is the final topic, with applications to the use of series in integration.

Math. 8a.—Differential and Integral Calculus. *Four class hours per week.* Continuation of Course 8.

Math. 9.—Differential Equations. *Five class hours per week.* The idea of this course is to bring before the student types of the equations met with in his other branches, and to introduce him to the methods needed for their solution; the series-methods naturally lead to a rather full study of hyperbolic functions. Theory is not neglected altogether, though the emphasis is laid on the practical handling of equations that actually occur in Physics and Mechanics.

Math. 100.—Mathematical Laboratory. *Five class hours per week.* This is a special course in which all students, who for one reason or another are deficient in Mathematics, will rectify this deficiency under the individual guidance of a member of the faculty. The new plan of studies requires of each student a passing mark of 70, not only in an entire branch like Trigonometry or Algebra, but in every chief topic of that branch; whenever a student, through sickness, or any other cause, has missed out in an important part or chapter of his work, he will be obliged to report regularly at the Laboratory class till his knowledge of that part, and the work handed in, reach the passing level. A student who has passed in Mathematics in his first and second years, but who later on manifests a weakness in any kind of Mathematical work that he is supposed to be familiar with, will likewise be subject to regular attendance at the Laboratory, by order of the Dean, till this weakness has been remedied.

MECHANICS.

Mech. 101.—Statics. *Five hours recitation per week during Summer term. Prerequisites, Physics 2 and Math. 8.* Resolution and composition of forces, couples, center of gravity, cords and pulleys.

Mech. 102.—Statics. *Five recitations per week for first two weeks.* Continuation of Mech. 101.

Mech. 103.—Mechanics of Materials. *Five hours recitation per week for last eight weeks. Prerequisites, Mech. 102.* Application of the laws of statics to the various materials used in engineering structures.

Mech. 104.—Mechanics of Materials. *Six hours recitation per week for first seven weeks.* Continuation of Mech. 103.

Mech. 105.—Dynamics. *Six hours recitation per week for last three weeks. Prerequisite, Math. 102.* The laws of moving bodies, translation, rotation, friction, belts, work and energy.

Mech. 106.—Dynamics. *Five hours recitation per week during Summer term.* Continuation of Mech. 105.

Mech. 201.—Hydraulics. *Three hours recitation and two hours laboratory per week. Prerequisite, Mech. 106.* A study of the elementary principles of the mechanics of fluids, fluid pressure and rigid bodies, laws of flowing water and methods and means of measuring.

Mech. 301.—Engineering Materials. *Three hours recitation per week. Prerequisites, Math. 6, and Physics 2.* A study is made of the properties and characteristics of materials used in engineering construction and the methods of manufacture of the same.

Mech. 302.—Testing of Materials. *Four hours per week in the laboratory. Prerequisite, Mech. 103.* Class tests to show methods of testing and the strength and general characteristics of various materials used in engineering construction.

Mech. 303.—Testing of Materials. *Four hours per week in the laboratory. Prerequisite, Mech. 302.* This is a continuation of Mech. 302 in which the student performs individual tests of the various engineering materials.

MODERN LANGUAGES.

French 1.—French. The work begins with oral exercises, and conducts the student through elementary grammar, including the more important irregular verbs; simple French prose should be understood and translated by the end of the year. Easy conversations are introduced.

French 2.—French. This course continues preceding work in grammar and syntax, and has for its object the free reading of standard prose; exercises in translation from English into French are frequently assigned. The purpose is to fit the student for wider professional reading.

German 1.—German. The easier grammatical forms, as far as the irregular verbs, are gone over, with translations and practical simple oral work.

German 2.—German. This course continues the work of German 1 in syntax and grammar, and by conversations, readings and themes prepares the student to read with some ease the standard German prose.

PHYSICS.

Physics 1.—Elementary Physics (with Laboratory). This is an elementary and descriptive course designed to give students a general idea of the principal phenomena and laws of physics. It is a prerequisite for Sophomores; and it is not given as a regular subject in the Freshman year of engineering, but is listed as an entrance requirement. Special students who lack this credit will be allowed to take this course in Freshman year.

Physics 2.—Mechanics, Molecular Physics and Heat. *Prerequisite, Trigonometry, and Physics 1. Four hours class.* This course corresponds to the first half of general or college physics. It calls for a careful analysis of principles and laws, their development, their correlation, and their practical applications. Special attention is given to mechanics.

Physics 3.—Electricity, Heat and Light. *Prerequisite, Physics 2. Four hours class.* In the continuation of General Physics the same analytic method is pursued in the discussion of the theories which underlie the phenomena of these subjects, and due emphasis is placed on the important application of the mechanics of waves and harmonic motion to these phenomena.

Physics 3a.—Electricity, Heat and Light. *Prerequisite, Physics 3. Three hours class work per week.* This is a continuation of Course 3.

Physics 6.—Advanced Physics. Sound, Heat, Light. *Prerequisites, Physics 2, 3; Mathematics 6, 7, 8.* This course goes into the mathematical theories of these subjects as well as the refined methods of modern research; and due attention is given to practical applications in engineering and the industries generally.

Physics 7.—Advanced Physics II. Electricity, Light and Heat.

The mathematical side of the subject is made prominent, and modern theories and methods are discussed from this standpoint. Practical applications receive due attention.

Physics 102.—Physical Measurements. *Laboratory corresponding to Physics 2. Four laboratory hours.* Quantitative determination of physical constants; adjustments and use of instruments of precision, such as the micrometer microscope, cathetometer, chronograph, etc. Verification of the laws of impact, of torsion and rigidity, of the composition of harmonic motions, of gravity; Young's modulus, Moment of Inertia, etc. Determination of specific heats, coefficients of expansion, laws of gases; hygrometry.

Physics 103.—Physical Measurements. *Laboratory corresponding to Physics 3. Four laboratory hours.* Experiments covering the laws of refraction, accurate measurements of indices of refraction, critical angle, magnifying power, photometry and spectrum analysis. Electro-static induction; theory of condenser; measurement of resistance; efficiency of electric motor; operation of alternator and transformer.

Physics 103a.—Physical and Electrical Measurements. *Six hours per week in laboratory.* Laboratory corresponding to Physics 3a. It is a continuation of Physics 103, including accurate electrical measurements.

Physics 106.—Measurements in Sound, Heat, Light. *Prerequisites, same as Physics 6.* A laboratory course, co-ordinates with Physics 6, in which accurate measurements are made in such phenomena as stationary waves, Lissajous' curves, etc., vapor tension, calorimetry; Spectrometer, diffraction, grating, polariscope, bi-prism, photometer and interferometer.

Physics 107.—Electrical Measurements. *Prerequisites, Physics 3 and Math. 8.*

The development of electrical theories. The laboratory work includes the calibration of measuring instruments; resistance of conductors, electrolytes, dialectrics, magnetic properties of iron, magnetometer, self-induction, inductance and capacity, high and low potentials.

PHILOSOPHY.

Course I. Logic. I; (4).
Course II. Psychology. I; (4).
Course III. Ethics. II; (4).

These courses are offered in the Arts and Sciences Department, but are open also to the Engineering Department.

Course IV. Business Ethics. I; II; (1).

This course will embrace the fundamental principles of right and wrong, of justice and injustice, together with the application of these principles to the many phases of industry, commerce and finance.

The purpose of the course is to develop and strengthen an intelligent business conscience.

Course V. Business Psychology. I, II; (1).

A course in practical psychology, including a study of the nature and development of the powers and mental faculties which make for character and efficiency.

Marquette University

Milwaukee, Wisconsin

*College of Arts and Sciences.**

Courses in Letters, Sciences and Philosophy, leading to the Bachelor's degree in Arts and Sciences.

College of Applied Science and Engineering.

Co-operative System of Engineering education. A five-year course leading to a professional degree in Civil, Mechanical, Chemical or Electrical Engineering.

School of Medicine.

A six-year course leading to the degree of Bachelor of Science and Doctor of Medicine.

College of Law.

a. The Day Law School, a four-year course leading to the degree of Bachelor of Laws;

b. The Evening Law School, a four-year course preparing for admission to the bar.

School of Dentistry.

A four-year course leading to the degree of Doctor of Dental Surgery.

*The R. A. Johnston School of Economics.**

a. A four-year course leading to the degree of Bachelor of Commercial Science;

b. A four-year course leading to the degree of Bachelor of Science in Economics.

c. A two-year Diploma Course.

*School of Journalism.**

Courses leading to the degree of Bachelor of Journalism, Bachelor of Arts in Journalism, Bachelor of Literature in Journalism and Bachelor of Science in Journalism.

Training School for Nurses.

Conducted in connection with Trinity Hospital. A three-year course.

Marquette University Conservatory of Music.

Instruction in Piano, Vocal, Violin, Organ and all orchestral instruments. Theory and History of Music, Dramatic Art, Art of Expression, Public School Music, Ensemble and Sight-Reading.

Marquette Academy.

Preparatory Department, Classical and Commercial courses, Courses preparatory to Law, Medicine and Engineering.

Summer School.

Six weeks' session during July and August.

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* These Departments also have evening sessions.

PROFESSIONAL ETHICS.

In the engineering, as in the other professional schools of Marquette University, a course in professional ethics is deemed an essential part of the curriculum.

The need of sound principles of morality in all the professions is now quite widely recognized.

A physician, a lawyer, an economist, or an engineer whose moral development does not compare favorably with his mental equipment can never win the confidence of his fellow men. They look askance at him and deem his presence in the community a menace to the home and a source of fear to the state.

Marquette solves the problem that is occupying the minds of many leaders in the engineering profession. "The present-day problem in engineering education," to quote a prominent member of the faculty of an engineering college in Iowa, "is how to educate our engineers better in the fundamentals of successful education. High qualities of manhood are absolutely essential in the engineer; so are high technical qualifications. . . . . .

"The engineer must pass a double test and not fail in either manhood or technical requirements. . . . . .

"No person should be ranked as an engineer who does not possess the manhood qualifications in a satisfactory degree, and this requirement should be separate from and in addition to satisfactory technical qualifications."

The Faculty of Marquette University considers it necessary for the weal of the family and civil society to insist upon professional ethics for the engineering students.

MARQUETTE UNIVERSITY

BULLETIN

SERIES III VOL. V
MARCH, 1920
NUMBER 3

College of Applied Science and Engineering

Published Monthly by Marquette University
1115 Grand Avenue
MILWAUKEE :: :: :: WISCONSIN

Entered as SECOND CLASS Matter April 12th, 1916, at the Post Office at Milwaukee, Wisconsin, Under the Act of August 24th, 1912.

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CALENDAR

1920

Aug. 1—**Entrance credits MUST be in hands of registrar.**
Aug. 30-31—**Monday and Tuesday—Entrance examinations.**
Sept. 1-4—Wednesday to Saturday—Registration for freshmen.
Sept. 6—Monday—Registration Sec. A. Shopwork begins Sec. B.
Sept. 7—Tuesday—Classes begin Sec. A.
Sept. 20—Monday—Registration Sec. B.
Sept. 21—Tuesday—Classes begin Sec. B.
Nov. 11-13—Thursday to Saturday—Thanksgiving recess Sec. A.
Nov. 25-27—Thursday to Saturday—Thanksgiving recess Sec. B.
Dec. 20-25—Holiday recess Sec. B.
Dec. 27, 1920 to Jan. 1, 1921 inclusive—Holiday recess Sec. A.

1921

Jan. 8—Saturday—First Term classes end Sec. A.
Jan. 22—Saturday—First Term classes end Sec. B.
Jan. 24—Monday—Registration Sec. A.
Jan. 25—Tuesday—Second Term begins Sec. A.
Feb. 7—Monday—Registration Sec. B.
Feb. 8—Tuesday—Second Term begins Sec. B.
May 21—Saturday—Second Term ends Sec. A.
May 23—Monday—Registration Sec. A.
May 24—Tuesday—Summer Term begins Sec. A.
June 4—Saturday—Second Term ends Sec. B.
June 6—Monday—Registration Sec. B.
June 7—Tuesday—Summer Term begins Sec. B.
July 2—Saturday—Classes end Sec. A.
July 23—Saturday—Classes end Sec. B.
July 25-Aug. 13—Vacation Sec. A.
Aug. 13—Saturday—Year closes Sec. B.
Aug. 15-Sept. 3—Vacation Sec. B.
Sept. 3—Saturday—Year closes Sec. A.

OFFICERS

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NAND SINGH, M.E.,
Intructor in Chemistry.

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Becker Construction Co.,
Consulting Engineer,
Milwaukee, Wisconsin.

MR. S. J. GATES,
Gates Engineering Co.,
Milwaukee, Wisconsin.

MR. T. CHALKEY HATTON,
Chief Engineer, Sewerage Commission,
Milwaukee, Wisconsin.

DR. E. KIDWELL, General Manager,
Kidwell Boiler and Engineering Co.,
Milwaukee, Wisconsin.

MR. W. R. McGOVERN,
General Manager, Wisconsin Telephone Co.,
Milwaukee, Wisconsin.

MR. L. C. WHEELER,
Erwin, Wheeler & Woolard,
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Milwaukee, Wisconsin.

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FOREWORD

The College of Engineering is the natural outgrowth of the expansion of Marquette University. Its location is fortunate, in being situated in a large manufacturing center; many and varied engineering enterprises are constantly in progress; and the friendly relations between Marquette University and the different shops, factories, and transportation companies give the student advantages that are of great benefit to him in his future career.

There is a strong demand for trained engineers, especially in the Northwest, owing to the industrial activity of the region. To equip men to meet this demand is the object and purpose of the Engineering Department; this equipment demands not only a solid foundation of theory, but above all, thorough drill in the practical applications of theory, to fit the student to grapple with the new and difficult problems he will be likely to meet.

In drawing up the Courses of Study, careful comparison has been made of the courses, and of the actual experiences gained by members of the faculty, in other standard engineering schools. An engineer's training cannot be narrow, and for this reason great importance is attached to English; the relative value assigned to other branches at Marquette is in close accordance with the usage of the prominent Schools and Universities. Every attempt will be made to maintain a high level of study and efficiency, and there is no hesitation in dropping from the rolls students whose application to work is considered unsatisfactory.

INFORMATION

For information concerning the College of Applied Science and Engineering address the Registrar, 1115 Grand Avenue. Interested persons are urged to call at the Registrar's office whenever possible, since personal interviews are much more satisfactory than correspondence.

REGISTRATION

The office of the Registrar, first floor of the Administration building of Marquette University, 1115 Grand Avenue, is open for consultation daily, except Sunday, 9-12 A. M., 2-5 P. M.

Appointments will be made by the Registrar at hours agreeable to both parties, should the above be inconvenient.

Students are urged to register at the specified time.

M. U. CO-OPERATIVE ENGINEERING PLAN

After mature deliberation, consultation with educators, practicing engineers, and industrial managers, and after a thorough investigation of Milwaukee's conditions and wonderful advantages, the trustees and faculty of the College of Applied Science and Engineering of Marquette University, decided to install what is known as the "Co-operative System of Engineering Education."

OBJECT.

Recognizing that the engineer of today is not merely the man who is able to perform difficult computations and produce therefrom certain designs, but that he is rather the man who can, in addition to the above, so direct the forces of nature, and the labor of man, as to make them useful and beneficial to the social and economic welfare of mankind, the faculty of this school has decided to adopt this system. It is not only the one system which will present to the student, our future engineers, th true laws governing the various forces of nature, their co-relations, their possibilities, their limitations, and their economic applications, by the actual application of the laws as they are studied, but it is the one system which presents the opportunity to study and observe the actual conditions, limitations, etc., of the human element (labor) involved, so as to apply nature's forces to bring forth products useful to mankind. The object of the "M. U." Co-operative Enginering Course is to instil into the young man's mind the proper use of the forces of nature (animate as well as inanimate) by giving the student an opportunity to actually apply these forces in conjunction with his study of the laws governing their application. This opportunity presented itself in the varied and wonderful industrial activity of Milwaukee. These industries were quick to see the great advantages of such a course, and extended to the school the facilities of their plants in hearty co-operation. Marquette's laboratories are, therefore, the industrial plants of this vicinity. The general plan, as worked out by the faculty with the representatives of the co-operating industries, is as follows:

PLAN.

The student body will be divided into two sections, A and B. Those in section A will spend two weeks at employment directly bearing upon the school courses, while those in section B are attending school. At the end of a two weeks' period, section B will start work, while section A attends school. Every man in section A will have an alternate in section B, who will take his place of employment when section A starts a period in school. The kind of work done by the students is very important, and consequently the faculty, considering it a vital part of the educational work, decides on this matter. The work is so laid out that at the end of the five year course, the student has a clear insight into the various phases per-

taining to that branch of engineering for which he is fitted or which he has chosen. The length of time spent at any one kind of work depends upon the work and the student's ability to grasp the principles involved. It may be said that the primary object of the co-operative course is not to make machinists or experts in any particular kind of employment, but rather to develop practical engineers.

With this purpose in view a number of firms have worked out schedules of employment for co-operative students. The following plan for Mechanical Engineers in one of the larger plants is a typical example:

Machine Shop...	Planer Milling Machine Tool Room Bench Work Lathe	12 months
Power Plant		1½ months
Foundry		1½ months
Engine Erecting Shop		3 months
Engineering Dept. and Metallurgical Lab.		6 months
Office and Accounting Dept.		3 months
Sales Department		3 months

STUDENT-EMPLOYES.

If this co-operative employment is to accomplish its purpose and put the student in touch with the actual conditions with which he must deal in the future, it is paramount that such employment must be real and not an imitation. The student, therefore, during his working period, will absolutely be an employee of the firm for which he is working, subject to such firm's rules, regulation and hours, and the orders of its foremen in every respect. The faculty will exercise no direct control over the students while at work, merely supervising them to see that their general class of work, conduct, etc., are up to the high standard required by this institution.

CO-ORDINATION

The shop work will be correlated with the school by means of the co-ordination course. This course consists of the employment above described, with visits to various plants supplemented by class room discussions conducted so as to bring out the important points to ascertain whether or not the student is applying himself. In addition to the above, the co-ordination course includes the work of the students in their own Engineering Society. Attendance at and participation in the meetings of this society is required because of the

realization that no man can properly fill a position of responsibility unless he is able to express his thoughts intelligently.

The co-ordination course is the connecting link between the theory taught in the classrooms and the application taught in the shops.

THE COURSE

It is evident that under such a system where the student spends one-half his time at school and the other half at employment, it is impossible to cover all of either the theory or its application in the old course of four years of eight months each. The "M. U." Co-operative Course, therefore, covers a period of five years of forty-eight weeks each. Each year is divided into two semesters of twenty weeks each and a summer term of eight weeks. There is a recess of two weeks between school years, and two recesses of one week each during the school year. These recesses occur consecutively and not simultaneously, for the two sections of the student body.

By such a program it has been found possible to easily cover all the fundamentals which both educators and practicing engineers agree are essential for the proper training of an engineering student. In addition the student is given a clear insight into engineering methods, or the application of what he is learning in school.

COMPENSATION

While the object of this system is purely educational, and the work for each student is so chosen as to give him a thorough knowledge of his particular branch of the profession, nevertheless the compensation received from his shopwork may often be the means of enabling a young man to complete his schooling. While the student is employed, as before stated, he is in every respect an employee of the firm for which he is working. He receives compensation for his work and such compensation is paid directly to him and is his. The amount earned by any particular student varies according to the kind of work, the student, and the length of employment. It will in general average around $300 per year. The University does control this phase of the subject. The amount earned, however, should make the average student independent of outside financial aid.

EQUIPMENT

The College of Applied Science and Engineering is well equipped with laboratories for all of the courses offered. The Chemical laboratory occupies the entire fourth floor of the Administration building, while the Physics laboratory occupies the entire third floor of the same building. Both of these have lecture halls equipped for demonstrations. The Astronomical observatory is located in the Ad-

ministration building, and is well equipped for all ordinary observations and student work.

The Engineering laboratories proper are located in the Engineering building. These laboratories are thoroughly equipped for carrying on the college experiments such as the tests of steam and gas engines to obtain their efficiency, power, performance, fuel consumption, etc., etc.

The Mechanical Engineering laboratory is equipped with both high speed and Corliss engines, gasoline and kerosene engines, pumps, condenser, air compressor, etc. Beside being able to make efficiency and performance tests on all this apparatus, it is also equipped for testing the quality of steam, fuel, analysis, calibrating guages, etc., and to make complete boiler tests.

The Heat Treating laboratory is equipped with furnaces, gas and electric, cyanide and quenching baths, pyrometers, polishing equipment etc. Hardness tests can be made by means of both Brinell and Shore methods. Micro-photographs can be taken of properly prepared specimens. The equipment allows for the heat treatment and investigation of iron and steel and their alloys.

A machine shop consisting of lathes, shapers, milling machines, surface and cylindrical grinders, drilling machines etc., is used for purposes of instruction and the building of special equipment for use in various departments. It is also possible by this means to conduct time study tests and so augment courses in production engineering and industrial management.

The Electrical Engineering laboratory is similarly equipped for making performance and efficiency tests, characteristics, etc., on the various types of generators, motors, transformers, converters, rectifiers, and the various other electrical appliances for both Direct and Alternating Current.

The Civil Engineering laboratories are equipped for testing the various materials of engineering structure, such as the metals, brick, sand, cement, etc., etc., in tension, compression, and cross-bending. The Hydraulic laboratory permits the testing of the flow of water and its measurement by weirs, pitometers, venturi meters, orifices, etc.

There is a good assortment of tapes, rods, levels, transits, compasses, plane tables, etc., with which to give the students thorough training in plane, topographic and railroad surveying.

LIBRARY FACILITIES.

The magnificent public library of the city, almost adjoining the School of Dentistry, is within two blocks of the Schools of Journalism, Arts and Sciences, Law, Economics, Engineering. The arrangement of the library is an ideal one for students, who have access to all the books for consultation and study, and may, with special privilege, take home with them as many books as are necessary

for the preparation of essays, debates, etc. The main library and its eight branches contain 325,000 volumes.

The Science room has about 25,000 volumes. On different shelves are books on Natural Science, Mathematics, Physics, Electricity, Chemistry, Geology, Biology, Archeology, Paleontology, Botany, Zoology, Birds, Mammals, Engineering and Agriculture.

In the History room are more than 40,000 volumes, including 15,000 on Sociology, 7,177 on Travel, 11,087 on Biography, and 11,900 on History. The Philosophy room contains about 5,000 volumes.

The Literature room contains 38,000 volumes, among which are American, English, French, German, Grecian, Roman, Italian, Spanish, Portuguese literatures, also a goodly number of Swedish, Danish, Dutch, Flemish, Semitic and Slavic and many books of Japanese, Chinese and Celtic literatures.

The College Library contains nearly 13,000 volumes. Its circulating department, accessible to the members twice a week, comprises standard English works, carefully selected with a view to the needs of the College students.

The library of the School of Applied Science and Engineering contains the latest volumes of all leading periodicals. The bound reports of the A. S. M. E. and many Engineering texts are available.

MUSEUM.

The Museum of the city of Milwaukee is within three minutes' walk of the University. The collection is one of the largest and finest in the United States, and contains hundreds of thousands of zoological, botanical, minerological and other specimens.

ENTRANCE REQUIREMENTS

ADMISSION.

All applicants for admission must present evidence of good moral character, and, if they come from another college, a certificate of honorable dismissal.

Admission by Certificate. A certificate from the principal of an accredited high school in which a student has been prepared for college will be accepted instead of examinations in the subjects offered for admission.

REQUIREMENTS FOR ADMISSION.

All candidates for a degree must present entrance credits amounting to the number of units specified in the course selected. A unit represents a year's study in a high school subject pursued five times a week.

SUBJECTS ACCEPTED FOR ADMISSION.

Latin.

(1) Grammar.—The entire Latin Grammar, including a knowledge of all regular syntactical constructions; translations into Latin, at sight, of complex English sentences, entailing the application of rules of relative clauses, indirect discourse and conditional sentences.

(2) Composition.—Translation into Latin of easy continuous prose, based on Caesar's Gallic War and on the Letters and Orations of Cicero.

(3) Authors.—Caesar: De Bello Gallico, four books. Ovid: Metamorphoses and Tristia. Cicero: The Orations against Cataline. Virgil: Aeneid, six books.

Greek.

(1) Grammar.—Etymology complete (including the irregular and defective forms); the rules of accents; syntax; the Homeric dialect.

(2) Composition.—Translation into Greek of simple English sentences based on Xenophan's Anabasis.

(3) Authors.—Xenophone; Anabasis, four books. Homer, Iliad, three books, or Odyessey, three books.

English—Rhetoric.

The candidate must be prepared on the matter contained in a standard text-book such as Hill, Coppens, Williams Genung, Carpenter, Thorndike, Brooks.

Composition.—A brief prose composition will be required, evidencing proficiency in the writing of clear, idiomatic English. The subject will be taken from the candidates' experience, or based on the books he presents for examination.

Fair penmanship and accurate spelling will considered as essential preliminary requirements.

English.

Texts prescribed for reading and study: Two plays of Shakespeare; Burke's Conciliation with the Colonies, or American Taxation; Irving's Sketch Book; one essay of Macaulay; Scott's Lady of the Lake; Goldsmith's Deserted Village; Tennyson's The Passing of Arthur; Lowell's Vision of Sir Launfal; Coleridge's Ancient Mariner.

The applicant should make himself familiar with the characters, the plot, incidents and characteristic diction of each work. Equivalents will be accepted.

French, German, Spanish.

1. Elementary grammar, easy prose and themes.
2. Snytax, moods, complex sentences, easy prose writing.
3. Good ready knowledge of standard prose, with syntax.
4. Acquaintance with classics and lyric poets.

The texts this year at Marquette are Chardenal (French) and Becker (German). Equivalent text-books must be used by students.

Spanish.

(Same as the first two years of German and French.)

History.

(1) Ancient History, including the history of the Oriental nations, Greece and Rome.

(2) Modern History from the foundation of the Holy Roman Empire to the present time.

(3) United States History and Civics.

History and Civics.

1. United States, or English History.
2. Ancient History.
3. European History.

Civics counts as ½ unit and may be combined with History.

Elementary Sciences.

The requirements are those of the standard High School texts, such as "McPherson and Henderson" (in Chemistry); "Martin" (in Physiology); "Linville and Kelly" or "Jordan and Gellogg" (in Zoology); "Atkinson" or "Bergen" (in Botany); "Milliken and Gaale" or "Mann and Twiss" or "Carhart and Chute" (in Physics); "Davis" or "Tarr" (in Physical Geography); "Howe" or "Todd" or "Young" (in Astronomy); "Norton" or "Tar" (in Geology). Work in Biology (eg. g., "Bailey & Coleman") may be offered as ½ unit in Zoology and ½ unit in Botany. All notes, note books, laboratory work, etc.,

in the above subjects, must be presented, especially in Physics, Chemistry and Geology, where they are absolutely required as essential to a proper course.

Algebra.

Fundamental operations, factoring, fractions, linear equations, radicals and exponents, quadratics, graphs, and problems involving all these are required; additional work in logarithms, elementary series, simultaneous quadratics, ratio and variations, binomial theorem, may be offered as ½ unit.

The six functions, and their relations, addition theorems, simpler transformations, the solution of plane triangles, right and oblique.

Geometry.

Any standard text; original demonstrations, loci, and numerical work are of great importance.

Vocational and Miscellaneous Subjects.

Such as Drawing, Commercial Law, Commercial Geography, Bookkeeping and Manual Training, are accepted with reluctance. A student offering such credits must furnish a comprehensive and full account of these studies and of the number of recitation or class hours spent in them, together with specimens of work done. Tests may be exacted if any doubt remains; and in no case will the total credits in this group be more than 4.

UNITS REQUIRED FOR ADMISSION.

The following units are required of all degree students:

Elementary Algebra	1½ units	History	1 unit
Plane Geometry	1 unit	Elementary Physics or	
Solid Geometry	½ unit	Elementary Chemistry	1 unit
English Composition	1 unit	Electives	7 units
English Literature	1 unit		

ELECTIVE UNITS.

The elective subjects that may be presented to complete the required units must be taken from the following list:

English	1 to 2 units
Spanish, French, German	1 to 2 units
Latin, Greek	1 to 2 units
Mathematics	1 unit

History (not more than four units in all):

Ancient History	1 unit
Medieval and Modern History	1 unit
English History	1 unit
United States History	1 unit

Science (not more than four units in all):	
Biology	1 unit
Botany	1 unit
Chemistry	1 unit
Physical Geography and Geology	1 unit
Zoology	1 unit
Physiology	½ unit
Vocational and Miscellaneous Subjects	4 units

Limitations.—Not more than four units will be accepted in any one subject. Students desiring credit in a foreign language must have at least two units in the subject. One unit of credit for a second foreign language will be given if the student has at least three units in the first language.

No Collegiate Credit is Given for High School Work.

SPECIAL STUDENTS.

The requirments as a special student will not be as rigid as for regular students, but will be governed in each case by the judgment of the Dean and faculty, concerning the applicant's fitness profitably to pursue the particular subject or subjects he may wish to follow.

Every applicant must present to the Dean a detailed and certified statement of his previous studies.

A special student may become a candidate for a degree if he has fulfilled the entrance requirements.

No one will be admitted as a special student unless he has passed his twentieth birthday.

ADVANCED STANDING.

Due credit will be allowed for advanced work done at the other Universities and Colleges of accepted standing, when work is closely similar to courses given in this school. Application for advanced standing may be made personally or in writing and should be accompanied by a detailed statement from the proper authority of the nature of the work for which credit is asked, and must be accompanied by letter of honorable dismissal.

SPECIAL LECTURES

by engineers, faculty members and invited guests are given to the engineering students at intervals during the year; many of these lectures are illustrated.

EVENING COURSES

both advanced and elementary, are conducted by the Engineering Department. General courses in Spanish, Chemistry, English, Elementary and Higher Mathematics, Mechanical Drawing, Mechanics,

Steam and Gas, Theory of Electricity, Structural Engineering, Metallurgy of Iron and Steel. Heat treatment of Iron and Steel are offered.

EXPENSES.

See chapter on tuition and fees used in General Catalogue.

A matriculation fee of $5.00 is charged every student when he decides to enter the University. This is not a recurrent fee and is charged each student but once during his course.

An athletic fee of $5.00 is charged every student annually, which admits him to all local games. Also an annual fee of $5.00 is charged to every male student for the Marquette Union. These fees are due in advance before entering the first term.

The regular tuition is $125.00 per year payable in advance as follows: $75.00 before beginning the first term, and $50.00 before beginning the second term.

A chemistry breakage deposit of $5.00 per year, partly returnable, is made at the beginning of the school year.

*Laboratory fees of $2.50 per term per Cr. Hr. is charged for all laboratory and field courses.

Books and instruments will cost about $30.00 for the Freshman year, and about $25.00 thereafter.

Board and room may be secured in close proximity to the University at about $8.00 per week.

The dues of the student's Engineering Society are $2.00 per year payable in two installments.

It is impossible to estimate such items as laundry, social activities and other such personal expenses as they vary greatly for different students.

REGULATIONS.

Every student shall carry at least 12 credit hours of work prescribed for the class in which he registers, otherwise he will be classed as a special. Reports are sent to parents or guardians at regular intervals regarding the student's standing and progress.

A final average below 60 for a semester's work in any subject will be considered a failure, and the student will be required to repeat the work in that subject at the earliest opportunity.

A final average above 60 and below 70 for a semester's work in any subject conditions the student. A condition will not prevent the student from pursuing advanced subjects, but the condition must be removed before the subject is repeated in the regular course, otherwise the student must repeat the subject. Examinations for the removal of conditions are held in January, June and September, and for each examination there is a special fee of $1.00. Conditional

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*No laboratory fees will be charged students of the classes of 1921 and 1922 who attended during the year 1919-'20.

examinations may, on special occasions be held at other than the above times, but the fee for such special examinations will be $2.00. All fees are payable in advance. The student will be held responsible for arranging to remove his own conditions.

A final average of 70 or over for a semester's work in any subject entitles the student to credit in that subject. This credit, however, may be partially or wholly withdrawn in case the student shows by his work in future courses that he lacks the necessary understanding in the prerequisite subject. In this case the student will be required to take such special work or repeat such portions of the prerequisite subject, as the Dean may prescribe.

A student who fails to complete his laboratory or drawing assignments within the time prescribed, will have his credits in such uncompleted subjects withheld until he has completed all such work to the satisfaction of the professor in charge. In case of failure to complete the work by the end of the next succeeding semester, the semester's work in the incompleted subject must be repeated.

PROBATION.

A student who fails to obtain a passing grade (70 or over) in one-half his work at the end of any term will be placed on probation for the next term. If, at the end of this probation period he is still below passing grade in one-half his work, he will be dropped from the school.

A student who is placed on probation for the second time, may at the discretion of the faculty, be dropped from the school.

ABSENCES.

Absences from classes without good and sufficient reasons will not be tolerated under any circumstances. In cases of excusable absences, the student will be given an opportunity to make up the lost work, but a continuation of absences will result in dismissal from the institution.

Absences from shop work will not be tolerated under any circumstances. If a student leaves his place of employment, "quits his job," without faculty consent, he is liable to be dismissed from the school, or to receive such other punishment as the Dean may deem fit.

Any student desiring special consideration, or exceptions from the above rules, must present his request in writing, with reasons, to the faculty, through the Dean. All such exceptional cases will be acted upon by the faculty as a whole.

DEGREES.

The University grants the professional degrees of Chemical Engineer (Ch.E.), Civil Engineer (C.E.), Electrical Engineer (E.E.), and Mechanical Engineer (M.E.), to students who have successfully completed the five-year co-operative course in any of the respective branches.

SCHEDULE OF COURSES
CHEMCIAL ENGINEERING

FIRST YEAR.

First Term		Hours Per Wk.
Math. 5	Advanced Algebra	6
Chem. 1	General Chemistry	7
English 1	English and Public Speaking	3
G. E. 101	Elementary Engineering	2
Drawing 1	Engineering Drawing	6
C-1	Co-ordination	1

Second Term		Hours Per Wk.
Math. 6 & 7	Trig. and Analytical Geometry	6
Chem. 2	General Chemistry	7
English 2	English and Public Speaking	3
C-2	Co-ordination	1
C. E. 101	Surveying	3
Drawing 2	Engineering Drawing	4

Summer Term		Hours Per Wk.
Drawing 3	Engineering Drawing	10
Chem. 3	Qualitative Analysis	12
C. E. 102	Surveying	12

SECOND YEAR.

First Term		Hours Per Wk.
Math. 7a & Math. 8	Analytical Geometry & Calculus	6
Physics 2	Mech., Molecular Physics and Heat	4
Drawing 4	Descriptive Geometry	7
Physics 102	Physical Measurements	4
Ch. E. 100	Metallurgy of Iron and Steel	2
C-3	Co-ordination and English	2

Second Term		Hours Per Wk.
Math. 8a	Calculus	5
Chem. 5	Quantitative Analysis	4
Physics 3	Electricity, Heat and Light	4
Physics 103	Physical Measurements	4
M. E. 201	Heat Engines	3
Ch. E. 101	Metallurgy of Iron and Steel	2
M. E. 202	Mechanical Laboratory	4
C-4	Co-ordination and English	2

Summer Term		Hours Per Wk.
Mech. 101	Statics	6
Ch. E. 209	Fuel and Gas Analysis	8
M. E. 201a	Heat Engines	2
Physics 3a	Electricity, Heat and Light	5
Physics 103a	Physical Measurements	4

THIRD YEAR—(Chemical Engineering).

First Term		Hours Per Wk.
Math. 9	Calculus-Differential Equations	5
Chem. 5a	Quantitative Analysis	8
Mech. 102 & Mech. 103	Statics & Mech. of Materials	6
M. E. 203	Mechanical Laboratory	4
E. E. 230	Direct Currents	3
C-5	Co-ordination and English	2

Second Term		Hours Per Wk.
Mech. 104 & Mech. 105	Mechanics of Materials & Dynamics	6
M. E. 100	Mechanism	8
Ch. E. 201	Inorganic Technical Analysis	8
E. E. 230a	Direct Currents	2
E. E. 231	Electrical Laboratory	4
C-6	Co-ordination and English	2

Summer Term		Hours Per Wk.
Mech. 106	Dynamics	6
Ch. E. 210	Iron and Steel Analysis	12
M. E. 203a	Mechanical Laboratory	8

FOURTH YEAR.

First Term		Hours Per Wk.
Ch. E. 206	Applied Electro-Chemistry	6
Chemistry 6	Organic Chemistry	7
Mech. 201	Hydraulics	5
E. E. 234	Alternating Currents	5
M. E. 101	Machine Design	8
C-7	Co-ordination and English	2

Second Term		Hours Per Wk.
Ch. E. 204	Applied Thermal Chemistry	3
Chemistry 6a	Organic Chemistry	7
Ch. E. 102	Metallography	6
Mech. 301	Engineering Materials	3
Mech. 302	Testing Materials Laboratory	4
E. E. 235	Electrical Engineering Laboratory	4
C-8	Co-ordination and English	2

Summer Term		Hours Per Wk.
Ch. E. 202	Organic Technical Analysis	16
C. E. 305	Structural Design	20

FIFTH YEAR—(Chemical Engineering).

First Term		Hours Per Wk.
Ch. E. 202	Organic Technical Analysis	8
Ch. E. 104	Heat Treatment of Steel	8
M. E. 303	Industrial Management	5
G. E. 201	Economics	3
C-9	Co-ordination and English	2
	Electives	3

Second Term		Hours Per Wk.
Chem. 7	Physical Chemistry	6
Ch. E. 207	Industrial Chemistry	3
M. E. 303a	Industrial Management	3
G. E. 301	Engineering Ethics	2
C-10	Co-ordination and English	2
	Electives	5

CIVIL ENGINEERING

FIRST YEAR.

First Term		Hours Per Wk.
Math. 5	Advanced Algebra	6
Chem. 1	General Chemistry	7
English 1	English and Public Speaking	3
Drawing 1	Engineering Drawing	6
C-1	Co-ordination	1
C. E. 101	Elementary Engineering	2

Second Term		Hours Per Wk.
Math. 6 & 7	Trig. and Analytical Geometry	6
Chem. 2	General Chemistry	7
English 2	English and Public Speaking	3
Drawing 2	Engineering Drawing	4
C. E. 101	Elementary Surveying	3
C-2	Co-ordination	1

Summer Term		Hours Per Wk.
Chem. 3	Qualitative Analysis	12
Drawing 3	Engineering Drawing	10
C. E. 102	Elementary Surveying	12

SECOND YEAR—(Civil Engineering).

First Term		Hours Per Wk.
Math. 7a & Math. 8	Analytical Geometry and Calculus	6
Physics 2	Mech., Molecular Physics and Heat	4
Physics 102	Physical Measurements	4
Drawing 4	Descriptive Geometry	7
Ch. E. 100	Metallurgy of Iron and Steel	2
C-3	Co-ordination and English	2

Second Term		Hours Per Wk.
Math. 8a	Calculus	5
Physics 3	Electricity, Heat and Light	4
Physics 103	Physical Measurements	4
C. E. 103	Plane Surveying	6
M. E. 201	Heat Engines	3
C-4	Co-ordination and English	2

Summer Term		Hours Per Wk.
Mech. 101	Statics	6
Physics 3a	Electricity, Heat and Light	5
Physics 103a	Physical Measurements	4
C. E. 104	Plane Surveying	8
M. E. 201a	Heat Engines	2

THIRD YEAR.

First Term		Hours Per Wk.
Math. 9	Calculus—Differential Equations	5
Mech. 102 & Mech. 103	Statics and Mechanics of Materials	5
C. E. 105	Topographical Surveying	9
M. E. 211	M. E. Laboratory	9
C-5	Co-ordination and English	2

Second Term		Hours Per Wk.
Mech. 104 & Mech. 105	Mechanics of Materials and Dynamics	6
C. E. 301	Theory of Structures	6
C. E. 201	Railroad Curves	3
Mech. 301	Engineering Materials	3
C-6	Co-ordination and English	2

Summer Term		Hours Per Wk.
Mech. 106	Dynamics	6
C. E. 202	Railroad Location	20

FOURTH YEAR—(Civil Engineering).

First Term		Hours Per Wk.
Mech. 201	Hydraulics	5
G. E. 201	Economics	3
C. E. 203	Railroad Location	6
C. E. 302	Structural Design	8
C. E. 351	Concrete	3
C-7	Co-ordination and English	2

Second Term		Hours Per Wk.
C. E. 401	Highways	3
Mech. 302	Material Testing Laboratory	4
C. E. 204	Railroad Const. and Maintenance	4
C. E. 303	Structural Design	8
C. E. 400	Hydrology	3
C. E. 352	Concrete	2
C-8	Co-ordination and English	2

Summer Term		Hours Per Wk.
C. E. 205	Railroad Location and Construction	8
C. E. 303	Structural Design	10
C. E. 353	Concrete Design	10

FIFTH YEAR.

First Term		Hours Per Wk.
Mech. 303	Testing of Materials	4
C. E. 403	Sewerage	3
C. E. 354	Concrete Design	3
C. E. 402	Water Supply	3
E. E. 236	Direct Currents	3
E. E. 237	Direct Currents Laboratory	4
C. E. 356	Foundations	3
C-9	Co-ordination and English	2

Second Term		Hours Per Wk.
C. E. 304	Bridge Design	12
E. E. 238	Alternating Currents	4
E. E. 239	Alternating Current Laboratory	4
G. E. 203	Contracts and specifications	3
G. E. 202	Business Organization	2
G. E. 301	Engineering Ethics	2
C-10	Electives	2
	Co-ordination and English	2

ELECTRICAL ENGINEERING

FIRST YEAR.

First Term		Hours Per Wk.
Math. 5	Advanced Algebra	6
Chem. 1	General Chemistry	7
English 1	English and Public Speaking	3
C-1	Co-ordination	1
G. E. 101	Elementary Engineering	2
Drawing 1	Engineering Drawing	6

Second Term		Hours Per Wk.
Math. 6 & 7	Trig. and Analytical Geometry	6
Chem. 2	General Chemistry	7
English 2	English and Public Speaking	3
C-2	Co-ordination	1
C. E. 101	Surveying	3
Drawing 2	Engineering Drawing	4

Summer Term		Hours Per Wk.
Drawing 3	Engineering Drawing	10
Chem. 3	Qualitative Analysis	12
C. E. 102	Surveying	12

SECOND YEAR.

First Term		Hours Per Wk.
Math. 7a & Math. 8	Analytical Geometry and Calculus	6
Physics 2	Mech. Molecular Phys. and Heat	4
Physics 102	Physical Measurements	4
Drawing 4	Descriptive Geometry	7
Ch. E. 100	Metallurgy of Iron and Steel	2
C-3	Co-ordination and English	2

Second Term		Hours Per Wk.
Math. 8a	Calculus	5
Physics 3	Electricity, Sound and Light	4
Physics 103	Physical Measurements	4
M. E. 201	Heat Engines	6
M. E. 202	Mechanical Laboratory	4
C-4	Co-ordination and English	2
Ch. E. 100	Metallurgy of Iron and Steel	2

Summer Term		Hours Per Wk.
Mech. 101	Statics	6
Ch. E. 209	Fuel and Gas Analysis	12
Physics 3a	Electricity, Sound and Light	5
Physics 103a	Physical Measurements	4

THIRD YEAR—(Electrical Engineering).

First Term		Hours Per Wk.
E. E. 102	Principle of Direct Currents	3
E. E. 101	Electrical Laboratory	4
Math. 9	Calculus; Differential Equations	5
Physics 107	Electrical Measurements	4
Mech. 102 & Mech. 103	Statics and Mechanics of Materials	6
C-5	Co-ordination and English	2
M. E. 203	Mechanical Laboratory	4

Second Term		Hours Per Wk.
E. E. 102a	Direct Currents and D. C. Machinery	3
Mech. 104 & Mech. 105	Mechanics of Materials and Dynamics	6
M. E. 100	Mechanism	8
C-6	Co-ordination and English	2
E. E. 103	Electrical Laboratory	4

Summer Term		Hours Per Wk.
Mech. 106	Dynamics	6
E. E. 108	Alternating Currents	3
E. E. 109	Direct Current Design	10

FOURTH YEAR.

First Term		Hours Per Wk.
E. E. 105	Electrical Laboratory	4
E. E. 108a	Alternating Currents	3
G. E. 201	Economics	3
G. E. 204	Principles of Accounting	3
Mech. 201	Hydraulics	5
C-7	Co-ordination and English	2
G. E. 205	Commercial Law	3

Second Term		Hours Per Wk.
E. E. 107	Electrical Laboratory	4
E. E. 110	Alternating Current Machinery	5
G. E. 204a	Principles of Accounting	3
Mech. 301	Engineering Materials	3
Mech. 302	Materials Testing Laboratory	4
C-8	Co-ordination and English	2
G. E. 205a	Commercial Law	3

Summer Term		Hours Per Wk.
E. E. 110a	Alternating Current Machinery	5
C. E. 305	Structural Design	20

*FIFTH YEAR—(Electrical Engineering).

First Term		Hours Per Wk.
E. E. 112	Central Stations	3
E. E. 116	Telephone Engineering	3
E. E. 118	Illumination and Photometry	3
E. E. 122	Electric Railway Engineering	3
M. E. 305	Industrial Management	5
G. E. 207	Corporation Finance	4

Second Term		Hours Per Wk.
E. E. 116a	Telephone Engineering	3
E. E. 118a	Illumination and Photometry	3
E. E. 122a	Electric Railway Engineering	5
G. E. 301	Engineering Ethics	2
	Electives	3

*On approval of the Head of the Department, Electric Railway Engineering, or Public Utility Engineering may be substituted for Electrical Engineering in the fifth year.

ELECTRIC RAILWAY ENGINEERING

First Term		Hours Per Wk.
E. E. 112	Central Stations	3
E. E. 122	Electric Railway Engineering	5
E. E. 142	Illumination	3
M. E. 303	Industrial Management	5
E. E. 130	Substation	3
G. E. 207	Corporation Finance	4

Second Term		Hours Per Wk.
E. E. 114	Central Stations	5
E. E. 119	Central Station Design	4
E. E. 120	Power Distribution	3
E. E. 122a	Electric Railway Engineering	5
G. E. 301	Engineering Ethics	2
M. E. 303a	Industrial Management	3

PUBLIC UTILITY ENGINEERING

First Term		Hours Per Wk.
E. E. 112	Alternating Current Problems	3
E. E. 113	Electrical Laboratory	4
E. E. 140	Telephony	3
E. E. 142	Illumination	3
G. E. 207	Corporation Finance	4
M. E. 303	Industrial Management	5
E. E. 112	Central Stations	3

Second Term		Hours Per Wk.
G. E. 301	Engineering Ethics	2
G. E. 209	American Government	3
G. E. 211	Salesmanship and Sales Administration	3
M. E. 303a	Industrial Management	3
E. E. 114	Central Stations	3
	*Electives	3

*These electives may be chosen from any department, subject to the approval of the Head of the Department.

MECHANICAL ENGINEERING

FIRST YEAR.

First Term		Hours Per Wk.
Math. 5	Advanced Algebra	6
Chem. 1	General Chemistry	7
English 1	English and Public Speaking	3
C-1	Co-ordination	1
G. E. 101	Elementary Engineering	2
Drawing 1	Engineering Drawing	6

Second Term		Hours Per Wk.
Math. 6 & 7	Trig. and Analytical Geometry	6
Chem. 2	General Chemistry	7
English 2	English and Public Speaking	3
C-2	Co-ordination	1
C. E. 101	Surveying	3
Drawing 2	Engineering Drawing	4

Summer Term		Hours Per Wk.
Drawing 3	Engineering Drawing	10
Chem. 3	Qualitative Analysis	12
C. E. 102	Surveying	12

SECOND YEAR—(Mechanical Engineering).

First Term		Hours Per Wk.
Math. 7a & Math. 8.	Analytical Geometry and Calculus	6
Physics 2	Mech., Molecular Phys. and Heat	4
Physics 102	Physical Measurements	4
Drawing 4	Descriptive Geometry	7
Ch. E. 100	Metallurgy of Iron and Steel	2
C-3	Co-ordination and English	2

Second Term		Hours Per Wk.
Math. 8a	Calculus	5
Physics 3	Electricity, Heat and Light	4
Physics 103	Physical Measurements	4
M. E. 201	Heat Engines	6
M. E. 202	Mechanical Laboratory	4
Ch. E. 101	Metallurgy of Iron and Steel	2
C-4	Co-ordination and English	2

Summer Term		Hours Per Wk.
Mech. 101	Statics	6
Ch. E. 209	Fuel and Gas Analysis	8
Physics 3a	Electricity, Heat and Light	5
Physics 103a	Physical Measurements	4

THIRD YEAR.

First Term		Hours Per Wk.
Math. 9	Calculus Differential Equations	5
Mech. 102 & Mech. 103.	Statics and Mechancs of Materials	6
E. E. 230	Direct Currents	3
M. E. 203	Mechanical Laboratory	4
C-5	Co-ordination and English	2
M. E. 200	Thermodynamics	2

Second Term		Hours Per Wk.
Mech. 105 & Mech. 104.	Dynamics and Mechanics of Materials.	6
M. E. 100	Mechanism	8
M. E. 200a	Thermodynamics	4
E. E. 230a	Direct Currents	2
E. E. 231	Electrical Engineering Laboratory	4
C-6	Co-ordination and English	2

Summer Term		Hours Per Wk.
Mech. 106	Dynamics	6
Ch. E. 210	Iron and Steel Analysis	12
M. E. 203a	Mechanical Laboratory	8

FOURTH YEAR—(Mechanical Engineering).

First Term		Hours Per Wk.
G. E. 201	Economics	3
G. E. 204	Principles of Accounting	3
G. E. 205	Commercial Law	3
Mech. 201	Hydraulics	5
M. E. 101	Elements of Machine Design	8
C-7	Co-ordination and English	2
E. E. 234	Alternating Currents	5

Second Term		Hours Per Wk.
Mech. 301	Engineering Materials	3
Mech. 302	Materials Testing Laboratory	4
G. E. 204a	Principles of Accounting	3
G. E. 205a	Commercial Law	3
Ch. E. 102	Metallography	6
C-8	Co-ordination and English	2
E. E. 235	Electrical Laboratory	4

Summer Term		Hours Per Wk.
C. E. 305	Structural Design	20
Ch. E. 104	Heat Treatment of Steel	20

*FIFTH YEAR (INDUSTRIAL ENGINEERING)

First Term		Hours Per Wk.
M. E. 303	Industrial Management	5
M. E. 304	Production Engineering	3
G. E. 206	Credits and Collections	3
G. E. 207	Corporation Finance	4
G. E. 208	Business Correspondence	2
	Electives	6

Second Term		Hours Per Wk.
M. E. 303a	Industrial Management	3
M. E. 304a	Production Engineering	3
G. E. 209	American Government	3
M. E. 206	Heating and Ventilating	6
G. E. 301	Engineering Ethics	2
	Electives	6

*Advertising, G. E. 210 may be substituted for G. E. 206 in the first semester and Practical Salesmanship and Sales Administration. G. E. 211 may be substituted for G. E. 209 in the second semester.

*FIFTH YEAR (RAILWAY MECHANICAL ENGINEERING)

First Term		Hours Per Wk.
M. E. 207	Power Plants	7
M. E. 303	Industrial Management	5
M. E. 304	Production Engineering	3
M. E. 212	Railway and Mechanical Engineering	3
E. E. 122	Electric Railway Engineering	3
C-7	Co-ordination and English	2

Second Term		Hours Per Wk.
M. E. 303a	Industrial Management	3
M. E. 213	Locomotive Operation	4
M. E. 214	Locomotive Design	8
G. E. 203	Contracts and Specifications	3
E. E. 122a	Electric Railway Engineering	5
G. E. 301	Ethics	2

*Note: Railway Mechanical Engineering may be substituted in place of Industrial Engineering or Steam and Gas Engineering.

*FIFTH YEAR (STEAM AND GAS ENGINEERING)

First Term		Hours Per Wk.
M. E. 204	Gas Engines	3
M. E. 211	Steam Turbines	2
M. E. 102	Gas Engine Design	8
M. E. 207	Power Plants	7
E. E. 112	Central Stations	3
C-7	Co-ordination and English	2

Second Term		Hours Per Wk.
M. E. 207a	Power Plants	5
M. E. 206	Heating and Ventilating	6
M. E. 210	Air Compressors and Refrig. Machs.	4
M. E. 103	Advanced Machine Design	4
E. E. 120	Power Distribution	3
G. E. 203	Contracts and Specifications	3
G. E. 301	Ethics	2

*Note: Steam and Gas Engineering may be substituted in place of Industrial Engineering or Railway Mechanical Engineering.

DESCRIPTION OF COURSES

GENERAL ENGINEERING.

G. E. 101.—Elementary Engineering. Two hours per week. This course consists of inspection trips to various industrial establishments together with written reports. It is especially designed to give freshmen a general idea of engineering equipment methods and purposes.

G. E. 201.—Economics. Three hours recitation per week. A study of the general principles of economics especially as it relates to engineering problems and activities.

G. E. 202.—Business Organization. Two hours recitation per week. This course shows the importance of organization in business and the tendencies of modern industrial development. The organization of certain businesses is studied to illustrate the principles.

G. E. 203.—Contracts and Specifications. Three hours recitation per week. A study of the importance and requirements of engineering contracts and specifications.

G. E. 204.—Principles of Accounting. Three hours per week. Elements of accounting, single and double entry; debits and credits; journalizing; posting and trial balances; closing books; proprietors' accounts; partnership accounts, etc.

G. E. 204a.—Principles of Accounting. Three hours per week. Advanced accounting; analytic study of the balance sheet; assets and liabilities; depreciation; capital stock; profits; surplus reserves; sinking funds; counting house methods, etc.

G. E. 205.—Commercial Law. Three hours per week. Contracts; negotiable instruments; agency; partnership; corporations.

G. E. 205a.—Commercial Law. Three hours per week. Sales; bailments; carriers; guaranty and suretyship; insurance; real property and tenancy.

G. E. 206.—Credits and Collections. Three hours per week. Forms of credit; classes of credit and credit machinery; duties and qualifications of the credit man; elements determining the credit risk; sources of credit; information; the financial statement; legal remedies of the creditor; extensions, compositions and adjustments; bankruptcy; insolvency and receivership; credit safeguards.

G. E. 207.—Corporation Finance. Four hours per week. A study of the organization and financial management of corporations including business promotion; principles of capitalization; means of financ-

ing an organization; determination of profits; valuation of securities; methods of consolidation; reorganization of corporations.

G. E. 208.—Business Correspondence. Two hours per week. The principles underlying every form of business; English; general correspondence; sales letters: follow-up letters; circulars, reports etc.

G. E. 209.—American Government. Three class hours per week. A study of the development and practical working of our federal, state and local governments.

G. E. 210.—Advertising. Three hours per week. Psychology of appeal; color; laws of memory; inducing action; analysis of successful advertisements; the advertising agency, etc.

G. E. 211.—Practical Salesmanship and Sales Administration. Three hours per week. Personal qualifications; tact; address and their development; a study of the elements that make for success; knowledge of the goods to be sold; studying the prospective buyer; approach, demonstration, presentation of argument; closing the sale, etc.

G. E. 301.—Ethics. Two hours per week. Goal of human activity, norm of morality; law, its sanction and source; rights and duties; professional ethics, etc.

CO-ORDINATION.

C-1, 2, 3, 4, 5, 6, 7, 8 and 9.—Two hours per week each. The assignment of practical engineering problems to be solved largely by observation aid study during the students' work period at the shops. This includes many written reports which are passed upon by both the English and Engineering Departments. It also includes participation in the regular meeting of the Engineering Association.

The latter organization has both a cultural and social end in view. It professes to train the young engineers under competent direction to fluency, ease and proficiency in public speaking. At the same time it affords an outlet for the social activities of its members.

CHEMICAL ENGINEERING COURSES.

Ch. E. 100.—Metallurgy of Iron and Steel. Two class hours per week. A study of the sources of raw material, methods of obtaining the ore and the various processes of producing steel; rolling mill and foundry practice.

Ch. E. 101.—Metallurgy of Iron and Steel. Two class hours per week. A continuation of Ch. E. 100, including the properties of special steels and their application to industry.

Ch. E. 102.—Metallography. Six hours per week in laboratory with lectures. Must be preceded by Course 100. This course consists of the microscopic examination of metals and alloys with special reference to the effects of heat treatment on steel.

Ch. E. 104.—Heat Treatment of Steel. Eight hours per week in laboratory. Must be preceded by Course 100. A laboratory study of modern methods in heat treatment of steel. Purposes of heat treating methods of temperature control, design of furnaces, annealing, hardening, tempering and case hardening.

Ch. E. 200.—Technical Pyrometry. Twelve hours per week. Laboratory study of high temperature measurements, calibration of thermo-couples, resistance pyrometers and the use of these instruments in industry.

Ch. E. 201.—Inorganic Technical Analysis. Eight laboratory hours per week. The technical methods of quantitative analysis of limestone and cement. Methods for the quantitative analysis of alloys.

Ch. E. 202.—Organic Technical Analysis. The technical methods of analysis or organic industrial materials; their identification and application to soap industry.

Ch. E. 204.—Applied Thermal Chemistry. Three lectures per week. Investigation of chemical reactions which take place at high temperatures.

Ch. E. 206.—Applied Electro-Chemistry. Two lectures and one four hour laboratory period. The application of the principles of electro-chemical and electro-thermal reactions to the decomposition of compounds, electro-plating and electro-quantitative chemical analysis.

Ch. E. 207.—Industrial Chemistry. Lectures, written reports and inspection trips. A study of industrial processes of chemical manufacture.

Ch. E. 209.—Fuel and Gas Analysis. Eight laboratory hours per week. Analysis of coal and coke, including calorimetric determinations by means of Hempel's apparatus. The application of the Orsat apparatus to the analysis of flue gases.

Ch. E. 210.—Iron and Steel Analysis. Twelve laboratory hours per week. The technical methods for determining the important constituents in iron, plain and alloy steels.

Ch. E. 211.—Water Analysis. (Industrial). Fitness for boiler and other industrial uses. The softening of water.

Ch. E. 212.—Water Analysis. (Sanitary). The analysis of potable waters. This course also includes the bacterial count and determination of the presence or absence of the bacteria of the colon group.

CIVIL ENGINEERING COURSES

TOPOGRAPHICAL GROUP.

C. E. 101.—Elementary Plane Surveying. One hour recitation and two hours field work per week. Prerequisites, Math. 6, and Engineering Drawing 1. Work covers theory and use of range poles, tape, and compass and the use and adjustment of the level. Notes, maps and reports are required. Pacing, chaining, compass surveys, differential, profile and contour leveling are included in the field work.

C. E. 102.—Elementary Plane Surveying. Two hours recitation and ten hours field work per week in summer term. Continuation of Course 101.

C. E. 103.—Plane Surveying. Two hours recitation and four hours field work per week. Prerequisites, C. E. 101 and C. E. 102. Takes up the use and adjustment of the transit and plant table, measurement of angles, transit and plane table surveys by tape and stadia methods, and topographic surveying.

C. E. 104.—Plane Surveying. Eighteen hours field work per week in summer term. Continuation of C. E. 103. Also, a study is made of the principles and practice of land and city surveying.

C. E. 105.—Topographic Surveying. Three hours recitation and six hours field work per week. Prerequisites, C. E. 103, and C. E. 104. Study is made of the theory and practice of surveying as applied to topographic work and includes base line measurement, triangulation, barometric and precise leveling, etc.

RAILWAY GROUP.

C. E. 201.—Railroad Curves. Three hours recitation per week. Prerequisites, C. E. 105 and C. E. 104. Study of simple, compound, reverse and spiral curves, turnouts and crossovers.

C. E. 202.—Railroad Location. Five hours recitation and fifteen hours field work per week during the summer term. Prerequisite, C. E. 201. Theory and practice of railroad location including reconnaisance and preliminary surveys, paper and final locations, developed by both class and field work. Mapping and office work is included.

C. E. 203.—Railroad Location. Six hours field and office work per week. Continuation of Course 202. Cross-sectioning, estimating quantities from center line profile and construction of mass diagram.

C. E. 204.—Railroad Construction and Maintenance. Four hours recitation per week. Prerequisite, C. E. 201. Study is made of the methods of calculation of earthwork and the theory of frogs and switches, maintenance of way, structures and appliances.

C. E. 205.—Railroad Location and Construction. Eight hours field work per week during the summer term. Prerequisite, C. E. 204. Calculation of earthwork and estimate of quantities in connection with given problems.

C. E. 206.—Railroad Terminals. Three hours recitation per week. Prerequisite, C. E. 204. Study is made of railroad terminals and yard layouts together with structures and appliances in connection therewith.

STRUCTURAL GROUP.

C. E. 301.—Theory of Structures. Six hours recitation per week. Prerequisite, Mech. 102. Study of determination by both analytical and graphical methods of the stresses in various types of roof and bridge trusses.

C. E. 302.—Structural Design. Eight hours per week in drafting room. Prerequisite, C. E. 301. In this course each student is given a different set of conditions under which he designs completely wooden and steel roof trusses.

C. E. 303.—Structural Design. Ten hours per week in drafting room. Prerequisite, C. E. 301. Complete design is made of railroad plate girder bridge.

C. E. 304.—Bridge Design. Twelve hours per week in drafting room. Prerequisite, C. E. 303. Each student is required to make a complete design of a pin connected railroad bridge.

C. E. 305.—Structural Design. Twenty hours per week in drafting room during Summer term. Prerequisite, Mech. 104. A course in the design of steel buildings especially arranged for Mechanical and Electrical Engineering students.

C. E. 306.—Bridge Engineering. Three hours recitation per week. Prerequisite, C. E. 301. This course takes up stresses in statistically indeterminate structures as well as the definition of structures and the determination of the true stresses in redundant members. Both graphic and analytic methods are used.

C. E. 307.—Advanced Bridge Design. Six hours per week in the drafting room. Prerequisite, C. E. 306. This course consists of the design of a swing bridge.

C. E. 351.—Principles of Reinforced Concrete. Three hours recitation per week. Prerequisites, C. E. 301 and Mech. 104. The theory of structures as applied to reinforced concrete design. Analysis and problems in design and construction.

C. E. 352.—Principles of Reinforced Concrete. Two hours recitation per week. Continuation of C. E. 351.

C.E. 353.—Reinforced Concrete Design. Ten hours per week in drafting room. Prerequisites, C. E. 351 and C. E. 352. A study of reinforced concrete as applied to building design. Actual designing of concrete beams, slabs, columns etc., is the vital part of this course.

C. E. 354.—Reinforced Concrete Design. Three hours per week in drafting room. A study is made of the various types of reinforced concrete construction. Complete design is made of reinforced concrete building.

C. E. 355.—Concrete Arches. Six hours per week in drafting room. Prerequisite, C. E. 356. This course consists of a series of lectures and design periods. The lectures apply the principles of statically indeterminate structures to concrete arches. The actual design of a concrete arch is made.

C. E. 356.—Foundations. Three hours recitation per week. Prerequisite, Mech. 104. A study of the principles and design of various types of foundations.

MUNICIPAL AND HYDRAULIC GROUP.

C. E. 400.—Hydrology. Three hours recitation per week. A study of precipitation, run-off, stream flow, evaporation, seapage, etc., as affected by topographical and geological conditions.

C. E. 401.—Highways. Three hours per week recitation. Prerequisite, C. E. 201. Design, construction and maintenance of highways and streets. The various types of pavements are studied.

C. E. 402.—Public Water Supply. Three hours per week recitation. Prerequisite, Mech. 201. Study of the principle features of water works design and construction including quantity and quality of potable water, sources of supply, design of distribution systems, reservoirs, dams and tanks.

C. E. 403.—Sewerage. Three hours per week recitation. Prerequisite, Mech. 201. Study of the design and construction of sewer-

age systems including surveys and estimates, determination of size and capacity of sewers and the various methods of sewerage disposal.

C. E. 404.—Irrigation and Drainage. Two hours per week recitation. Prerequisite, Mech. 201. A study of the principles of irrigation engineering including various methods and means of irrigating and the design and construction of reservoirs, canals, flumes and other irrigation works. Also, the principles involved in the reclamation of land by drainage.

C. E. 405.—Water Power Engineering. Three hours per week recitation. Prerequisite, Mech. 201. A study of the principles involved in the consideration of a water power project such as the effects of variation of flow, head, etc., types, characteristics, selection and installation of water wheels.

ELECTRICAL ENGINEERING COURSES

E. E. 101.—Electrical Laboratory. Four hours per week in laboratory. Prerequisite, E. E. 102. A course of laboratory exercises designed to familiarize the student with the use of the common laboratory apparatus and with the practical operation of the ordinary types of direct current machines.

E. E. 102.—Direct Currents and Direct Current Machinery. Three class hours per week. Prerequisites, Math. 8, Physics 2, Physics 3, Physics 102 and Physics 103. A course of lectures, recitations and problems devoted to the fundamental concepts of Electrical Engineering; the laws and properties of Electric and Magnetic circuits; and the theory underlying the construction and performance of direct current machinery.

E. E. 102a.—Direct Current Machinery. Three class hours per week, E. E. 102a. Prerequisite, E. E. 104. This is a continuation of E. E. 104.

E. E. 103.—Electrical Laboratory. Four hours per week in the laboratory. Prerequisite, E. E. 101 and E. E. 104; E. E. 104a must accompany or precede this. This is an experimental study of the work covered in E. S. 104 and E. E. 104a. The tests include the determination of the characteristics, efficiency, regulation, and heating, of direct current motors.

E. E. 105.—Electrical Laboratory. Four hours per week in laboratory. Prerequisites, E. E. 101; E. E. 106 must accompany, or precede, this course. This course consists of a series of laboratory exercises arranged to familiarize the student with the practical operation of the ordinary alternating current apparatus.

E. E. 108.—Alternating Currents. Three hours per week in classroom. Prerequisites, E. E. 104a. This work begins with a physical and mathematical study of the effect of the various quantities in alternating current circuits. The general plan is to convey first a mental conception of the different relations and then to show how these relations may be expressed mathematically and graphically. The symbolic method is also studied. Practical problems are given to illustrate the use of the different methods and to familiarize the student with practical applications of alternating currents. This includes a study of polyphase alternating currents.

E. E. 108a.—Alternating Currents. Three hours per week. Prerequisite, E. E. 108. Continuation of E. E. 108.

E. E. 109.—Electrical Design. Two hours per week lectures, and six hours per week in drawing room. Prerequisites, E. E. 104a, and Drawing 3. The calculations in the design of direct current machinery are first considered by studying in detail, the design of various types and sizes of machines, then the derivations of the equations after which the student is required to make the calculations and detail drawings for a specified machine.

E. E. 110.—Alternating Current Machinery. Five class hours per week. Prerequisite, E. E. 108. The mathematical and graphical methods are next applied to the study of alternating current machines, beginning with the transformer, then taking up in logical sequence the induction motor; alternators; converters; commutator types of alternating current motors; insulations; corona; short transmission lines and regulation by power factor. The operating characteristics and practical applications of these machines are studied and the characteristics of the different apparatus are taken up to show their special fitness for the various classes of service they are required to perform.

E. E. 110a.—Alternating Current Machinery. Five class hours per week, for four weeks. Prerequisite, E. E. 110. This is a continuation of E. E. 110.

E. E. 107.—Electrical Laboratory. Four hours per week, in laboratory. Prerequisites, E. E. 105 and E. E. 108. This is an experimental study of alternating current circuits involving combinations of resistance, inductive reactance and capacity reactance

in series and parallel circuits, after which the study of transformers is taken up in detail.

E. E. 112.—Central Stations. Three hours per week in class-room. Prerequisite, E. E. 110. The operation of central station apparatus is taken up and studied both in regard to econmy of operation and to mehods of manipulation.

E. E. 114.—Central Stations. Five hours per week. Prerequisite, E. E. 112. Continuation of course E. E. 112.

E. E. 114.—Electrical Station Practice. Two hours per week in class-room. Prerequisite, E. E. 110. The operation of central station and sub-station apparatus is taken up and studied both in regard to economy of operation and to methods of manipulation.

E. E. 115.—Electrical Design. Two hours per week lectures, and eight hours per week in drawing room. Prerequisites, E. E. 109 and E. E. 110a. A course similar to E. E. 109 with the exception of considering alternating current machinery instead of direct current machinery.

E. E. 116.—Telephone Engineering. Three class hours per week. Prerequisite, E. E. 106. This course includes a detailed study in class of the fundamental principles and construction of modern telephone equipment and circuits for all classes of service. Wireless telegraphy and telegraph instruments and systems are studied briefly in the latter part of the course.

The class work is accompanied by an individual study of the apparatus and its connections, in the laboratory, and by visits to manufacturing and operating centers in the city.

E. E. 116a.—Telephone Engineering. One hour per week in class-room and four hours per week in laboratory or inspection trips. Prerequisite, E. E. 116. This is a continuation of Course E. E. 116.

E. E. 118.—Illumination and Photometry. Three class hours per week. Prerequisite, E. E. 108. A consideration of light, standards of light and photometry, illuminants of combustion, incandescent lamps and arc lamps, shades and reflectors, and illumination of residences, large interiors and streets.

This course is supplemented by laboratory work involving the investigation of the accuracy and sensibility of photometric devices, manipulation and use of photometers, investigation of the illumination of and reflection from walls and ceiling, study of the direct, semi-direct and indirect lighting systems, and the efficiency of different classes of reflectors.

E. E. 120.—Power Distribution. Three class hours per week. Prerequisite, E. E. 110. A study of the principles and layouts of direct and alternating current distribution for light and power purposes, methods of installation and regulation of typical circuits for above are studied and the student is required to design one complete layout from data given him.

E. E. 122.—Electric Railway Engineering. Five class hours per week. Prerequisite, E. E. 110. This course treats of the design, construction, and operation of electric railways, from the preliminary field engineering to the final calculations of income and operating expenses. This includes a treatment of preliminary survey of the region considered, speed—time—energy—curves, motor characteristics, schedules; choice of motor, acceleration, and character of system; load curves, generating station, sub-station, distributing system, construction and operation of the road; and the financial items involved. A typical design is carried through to illustrate the methods actually employed in the design of a high speed interurban system.

In addition to the lectures the student will devote three hours per week to the design of a particular system, starting from data on the nature of the proposed road, character of the business, etc., and will work out the electrical equipment completely.

E. E. 122a.—Electric Railway Engineering. Two hours per week in class room and three hours per week in drawing room. Prerequisite E. E. 122. This is a continuation of course E. E. 122.

E. E. 126.—Transformer Practice. Two class hours per week. Prerequisite, E. E. 110. This course takes up the operation of transformers from the practical standpoint and includes the selection of transformers for various purposes and methods of connecting them for phase transformation, etc.

E. E. 130.—Electric Railway Substations. Three hours per week. Design, operation and maintenance of automatically and manually operated substations.

E. E. 140.—Telephony. Three hours per week in class-room. Prerequisite, E. E. 108. This is a condensed course consisting of lectures and recitations which gives the student a general knowledge of the construction and operation of telephone systems and central telephone station practice.

E. E. 142.—Illumination. Three hours per week. Prerequisite, E. E. 108. This is a condensed course consisting of lectures, recitations, and laboratory exercises, designed to give the student a general knowledge of the production, measurement, and utilization of light.

THE FOLLOWING COURSES ARE OPEN TO STUDENTS FROM OTHER DEPARTMENTS:

E. E. 230.—Direct Currents. Three class hours per week. Prerequisites, Math. 8 and Physics 2. The work covered in this course includes part of Courses 102 and 104, and develops the theory of direct current machines, generators, and motors especially, with a view to familiarize the student with the various types of machines, the difference of design, and the effect of these differences on operation, without working out the rules governing designs. Special attention is given to motors regarding speed variation and applicability to various purposes.

E. E. 230a.—Direct Currents. Two class hours per week. Prerequisite, E. E. 230. This is a continuation of E. E. 230.

E. E. 231.—Electrical Laboratory. Four hours per week in laboratory for five weeks. Prerequisite, E. E. 230. The important operating characteristics of generators and motors are obtained experimentally, the purpose being to show the difference between types of machines and to give the student a knowledge of the erection and operation of such machine.

E. E. 232a.—Alternating Currents. Two class hours per week. Prerequisite, E. E. 232. This is a continuation of E. E. 232.

E. E. 234.—Alternating Current Machinery. Five class hours per week. Prerequisite, E. E. 230a. Some time is given to the development of the theory of the alternating current circuit. A discussion of the theory of commercial alternating current machinery follows. As in 230 the effort is to make clear the differences in construction, operation, and availability of the various types of alternators, transformers and motors. All working formulae for design are omitted.

E. E. 235.—Electrical Laboratory. Four hours per week in laboratory. Prerequisites, E. E. 231 and E. E. 232 or E. E. 234. laboratory. Prerequisites, E. E. 231 and E. E. 234. After introducing experiments on alternating current circuits, others on generators, transformers, and motors follow. These experiments are to show the characteristic of the various machines and to familiarize the student with connecting and operating them.

E. E. 236.—Elements of Direct Currents and Direct Current Machinery. Three class hours per week. Prerequisites, Math. 9 and Physics 3. The work covered includes a brief study of electric and magnetic circuits; the operation and use of those electrical instru-

ments used in the measurement of resistance, current, potential, power and energy; the theory and principles of construction and operation of direct current motors and generators and their auxiliary equipment.

E. E. 237.—Electrical Laboratory. Four hours per week in laboratory. This course is the laboratory accompaniment to Course 236.

E. E. 238.—Elements of Alternating Currents and Alternating Current Machinery. Four class hours per week. Prerequisite, E. E. 236. This course includes a brief study of the principles of alternating current and the principles of construction and operation of alternating current motors and alternators and their auxiliary equipment.

E. E. 239.—Electrical Laboratory. Four hours per week in laboratory. Prerequisite, E. E. 237. This is an experimental study of the principles covered in Course 238 and is given parallel with it.

MECHANICAL ENGINEERING COURSES

MACHINE DESIGN GROUP.

M. E. 100.—Mechanism. Two class hours per week. Six hours per week in drafting room. Must be preceded by Math. 7 and Drawing 2. A systematic study is made of velocity diagrams and of the various forms of motion occurring in machines. A considerable part of the time is devoted to the design of cams and gears.

M. E. 101.—Machine Design. Eight hours per week in drafting room. Must be preceded by Course 100 and Mech. 106 and 104. This is a continuation of Course 100 with the application of mechanics necessary for determining the strength of machine parts. Each student is required to complete the design of some simple machine.

M. E. 102.—Steam and Gas Engine Design. Eight hours per week in drafting room. Must be preceded by Courses 101, 200 and 201. This is essentially a course in design supplemented with lectures on the methods employed in determining the more important details of steam and gas engines.

Problems are assigned requiring the application of thermodynamic principles as well as the use of emperical formulae.

M. E. 103.—Advanced Machine Design. Four hours per week in drafting room. Must be preceded by Course 102. Lectures and drafting room work, dealing with the study of inertia forces that arise in various kinds of machinery, especially where high speeds are employed, and the methods of balancing these forces. This includes investigation of governors, dynamo armatures, centrifugal

machines, the gyroscope and its application, and the balancing of multi-cylinder engines.

M. E. 104.—Machine Design. Six hours per week in the drafting room. Lectures and drafting room work, dealing with the principles of machine design particularly of apparatus employed in chemical manufacture.

STEAM AND GAS ENGINEERING GROUP.

M. E. 200.—Applied Therodynamics. Two class hours per week. Must be preceded by Mech. 1, Physics 3, Chem. 2. This Course embraces a detailed study of the elementary principles of thermodynamics, entropy, properties of steam, principles underlying the simple and multiple expansion steam engine, and the Carnot and Rankine cycles.

M. E. 200a.—Thermodynamics. Four class hours per week. Prerequisite, M. E. 200. A continuation of M. E. 200.

M. E. 201.—Heat Engines. Six class hours per week. This course embraces a study of the various types of steam boilers and accessories, simple and compound engines, steam turbines, air compressors and the internal combustion engine.

M. E. 201a.—Heat Engines. Two class hours per week during the summer term. Continuation of Course 201. Prerequisites, Course 201.

M. E. 202.—Mechanical Laboratory. Four hours per week in laboratory. Must be preceded by Mechanics 102, Physics 3, Chemistry 2. This course runs parallel with Course 201. It includes the calibration of pressure gauges, thermometers, meters, etc., practice in the use of the steam engine indicator. It is intended to familiarize the student with mechanical laboratory instruments.

M. E. 203.—Mechanical Laboratory. Four hours per week in laboratory. Must be preceded by Course 202. This is a continuation of Course 202 including steam calorimeter tests, analysis of flue gases, flow of steam through orifices, steam engine valve setting, and mechanical and efficiency tests of steam engines.

M. E. 203a.—Mechanical Laboratory. Eight hours per week during summer term. Continuation of M. E. 203. This course consists of fuel tests, consumption, mechanical and thermal efficiency tests of gas and kerosene engines.

M. E. 204.—Gas Engines. Three class hours per week. Must be preceded by Course 201. A study of the internal combustion engine based on theory and practice. The various types of engines are

studied with particular attention to the fuels used, carbureting ignition, governing, lubrication, timing of valves, and general operating conditions. The course includes a study of recent developments in the design of Diesel and other engines.

M. E. 205.—Mechanical Laboratory. Four hours per week in laboratory. Must be preceded by Course 204. Evaporative tests of boilers, steam consumption, and power development of an electrical plant, tests of air compressors, steam pumps and injectors, the determination of efficiencies, losses, and characteristics of gas and oil engines.

M. E. 206.—Heating and Ventilating. Two class hours per week. Four hours per week in drafting room. Direct and indirect steam and hot water heating, gravity systems, vacuum systems, direct air heating, ventilating, temperature and humidity control, heating boilers and furnaces. The course includes a complete layout of a heating and ventilating system for a typical building.

M. E. 207.—Power Plants. Seven hours per week. Drafting room supplemented by lectures. This course includes a discussion of the mechanical problems involved in the selection of power plant units, including auxiliary equipment. Each student is required to select and arrange a complete plant equipment.

M. E. 207a.—Power Plants. Five hours per week. A continuation of Course M. E. 207 which includes a more detailed study of power plan equipment, location, design and economy.

M. E. 208.—Compressed Air. Two class hours per week for one term. Must be preceded by Course 201. A mathematical treatment of the problems entering into the production, transmission, and application of compressed air. A study is made of the air compressor with particular reference to the effect of clearance, methods of cooling, advantages of compounding, etc. Attention is given to the hydraulic compressor, measurement of air, friction of air in pipes, and the air lift.

M. E. 209.—Refrigeration. Two class hours per week for one term. Must be preceded by Course 201. This course is designed to give the student a working knowledge of the problems entering into the selection of a mechanical refrigeration plant and includes a complete description of the various types of commercial ice machines and systems of refrigeration.

M. E. 210.—Air Compressors and Refrigerating Machines. Four class hours per week. This course includes in its scope the design and construction, operation and maintenance of air compressors and refrigeration machinery.

M. E. 211.—Steam Turbines. Two hours per week for one term. Must be preceded by Course 201. The thermodynamic principles underlying the design of steam turbines and the discussion of various

types, their adaptability for different classes of service, and a comparison with the reciprocating engine.

M. E. 212.—Railway Mechanical Engineering. Three class hours per week. This course purposes to deal jointly with the construction of locomotives and cars; interchange of parts; car lighting and heating, maintenance of railway equipment; terminals; classification and operating statistics.

M. E. 213.—Locomotive Operation. Four class hours per week. This course deals with the mechanical performance of the locomotive, rate of combustion, draft, boiler efficiency, steam distribution in the cylinder, variations of power with speed, superheaters, economizers, and other important apparatus affecting the performance of the modern locomotive.

M. E. 214.—Locomotive Design. Eight hours per week in drafting room. A study of the principles underlying the design and construction of the locomotive. The engine with its parts, valves, piston, cylinder, cross-head, connecting rods, valve gears and the steam generating plant are gone into separately.

INDUSTRIAL ENGINEERING GROUP.

M. E. 303.—Industrial Management. Five lectures or recitations per week. The various methods of control of industry; cost accounting; distribution of expense; purchasing; sales organization.

M. E. 303a.—Industrial Management. Three lectures or recitations per week. A continuation of M. E. 303 which includes discussion of labor problems; welfare work; safety and sanitation.

M. E. 304.—Production Engineering. Three class hours per week. A detailed study of problems involved in shop management such as routing of products; time study and bonus systems; depreciation of equipment; stock records; inspection systems; safety devices and the human element in production.

M. E. 304a.—Production Engineering. Three or four hours per week. A continuation of M. E. 304 which includes numerous inspection trips and the written reports on shop processes and equipment.

GENERAL COURSES

ACCOUNTING.

COURSE I. General Accounting. I, II; (2).
COURSE II. Corporation Accounting. I, II; (2).
COURSE IV. Cost Accounting.
These courses are offered in the College of Economics, but are open also to the students of the Engineering Department.

ASTRONOMY.

Young's Astronomy—historical, descriptive and practical. Lectures and recitations. For reference, Clerk's History of Astronomy, Newcomb's "The Stars"; Lockyear, Langley.

CHEMISTRY.

Chem. 1.—General Chemistry. Two lectures, one recitation, and two two hour laboratory periods. The study of the fundamental laws and theories; the non-metallic elements and their important compounds.

Chem. 2.—General Chemistry. Two lectures, one recitation, and two two-hour laboratory periods. Review of chemical theories and continuation of the study of chemical elements and their compounds; supplemented by chemical problems.

Chem. 3.—Qualitative Analysis. Twelve laboratory hours, Summer term. The chemistry of the metallic elements and their compounds; the application of chemical theory to the formation of insoluble compounds; the separation of bases and acids; the solution and analysis of alloys, ores, and inorganic elements or compounds in the presence of organic matter.

Chem. 5.—Quantitative Analysis.—Gravimetric. Two two-hour laboratory and class room periods. Through individual laboratory instructions stress is laid upon care and accuracy. This course is devoted to the gravimetric method of determination. This includes the types, use and care of analytical balances, a selected number of gravimetric determinations of basic and acid constituents to illustrate the different conditions of precipitation, washing, drying, decomposition and weighting of precipitates.

Chem. 5a.—Quantitative Chemical Analysis.—Volumetric. Two four-hour laboratory and class room periods. The use and calibration volumetric apparatus. Selection and use of indicators; preparation and standardization of volumetric solutions. A selected number of acidimetric alkalimetric, oxidimetric and precipitation determinations.

Chem. 6.—Organic Chemistry. Three lectures, one recitation and one four-hour laboratory period. The general principles and theories of organic chemistry; physical and chemical properties of the compounds of the open chain series.

Chem. 6a.—Organic Chemistry. Two lectures and one four-hour laboratory period. This course is a continuation of Course 6. Physical and chemical properties of the closed chain series.

Chem. 7.—Physical Chemistry. Two lectures and one four-hour laboratory period. The physico-chemical relations. The general principles of chemistry are studied and closely correlated with the laboratory work. The practical applications of the subject are emphasized.

DRAWING.

Drawing 1.—Elementary Drawing. Six hours drawing room work during first term. Required of all Engineers. The course consists of practice in the use of instruments, practice in lettering and elementary orthographic projections.

Drawing 2.—Elementary Drawing. Four hours drawing room work during second term. Prerequisite, Drawing 1. Required of all Engineers. This course consists of lettering, orthographic and oblique projections.

Drawing 3.—Advanced Drawing. Ten hours drawing room work during Summer term. Prerequisite, Drawing 2. This is a course of technical sketching, isometric and cabinet projections.

Drawing 4.—Descriptive Geometry. One lecture and recitation hour and six hours drawing room work during first term. This is a study of orthographic projections as applied to the solution of problems involving the point, line and plane; the representation of curved and warped surfaces, and the intersections and developments. Many problems are assigned for home work.

ENGLISH.

English 1.—Three class hours per week. The object of this course is to fit the future engineer for the use of English most called for in his life work. Therefore, while other forms of expression are not neglected, chief stress is laid on exposition both oral and written. The great need of the engineer is to be able to express his ideas clearly, cogently, and effectively.

Daily exercises are given in written and oral exposition as a regular part of the class work. Besides the criticism of the professor, the members of the class are called upon to offer their opinions of each exercise.

English 2.—Three class hours per week. Continuation of Course 1. In addition to this, papers on physical, chemical, and electrical topics submitted to professors of other departments will be criticized from the viewpoint of correct and idiomatic English.

GEOLOGY.

General course in dynamic, structural, physiographic, historical, and economic geology. Principles of petrology, mineralogy and paleontology. Study of the field work of the Wisconsin Geological Survey. The College possesses a collection of the more important minerals, and rocks; in addition to this the students have access to the Public Museum, the entire third floor of which is devoted to geology.

Lectures, field work, identification of life forms, recitations and written exercises. Text: Le Conte: Salisbury and Chamberlain. For reference: The extremely valuable publications of the Wisconsin Geological Survey and the United States Geological Surveys Monographs and Bulletins.

MATHEMATICS.

Math. 5.—Advanced Algebra. Six class hours per week. A brief but thorough review of the foundations is given (negative and irrational numbers, indices, fractions, graphic and analytic discussion of linear and quadratic equations), after which the following topics are treated: determinants, logarithms, complex numbers, solution of higher equations, introduction to series, convergence-tests, undetermined coefficients.

Math. 6.—Trigonometry. Six class hours per week, first part of term. The elementary functions, their relations, their graphs; functions of sums, differences and multiples of angles; solutions of all case of plane and spherical triangles; solution of pure and mixed trigonometrical equations by graphic methods. Emphasis is laid on the practical use of formulas, rather than on their derivation.

Math. 7.—Analytical Geometry. Six class hours per week last part of term. A thorough study of graphic methods precedes this course, after which the line, the individual conics, and the general conic are treated with sufficient completeness. The spirit and methods of analytic geometry are emphasized, and illustrations are drawn from transcendental and higher algebraic curves whenever possible. The essentials of solid geometry are given.

Math. 7a.—Analytic Geometry. Six class hours per week for first six weeks. Continuation of Course 7.

Math. 8.—Differential and Integral Calculus. Six class hours per week for last three weeks. The fundamental formulas and

processes of differentiation are followed by applications to maxim and minima, inflexions, envelopes and evolutes; integration, both formal and as a summation, follows at once, with applications to curves, chanics will be maintained, so that certain types of differential equasurfaces, and volumes. A close connection with the classes in Metions will be taken up as soon as possible. Taylor's Theorem and the subject of series in general is the final topic, with applications to the use of series in integration.

Math. 8a.—Differential and Integral Calculus. Five class hours per week. Continuation of Course 8.

Math. 9.—Differential Equations. Five class hours per week. The idea of this course is to bring before the student types of the equations met with in his other branches, and to introduce him to the methods needed for their solution; the series-methods naturally lead to a rather full study of hyperbolic functions. Theory is not neglected altogether, though the emphasis is laid on the practical handling of equations that actually occur in Physics and Mechanics.

Math. 100.—Mathematical Laboratory. Five class hours per week. This is a special course in which all students, who for one reason or another are deficient in Mathematics, will rectify this deficiency under the individual guidance of a member of the faculty. The new plan of studies required of each student a passing mark of 70, not only in an entire branch like Trigonometry or Algebra, but in every chief topic of that branch; whenever a student, through sickness, or any other cause, has missed out in an important part or chapter of his work, he will be obliged to report regularly at the Laboratory class till his knowledge of that part, and the work handed in, reach the passing level. A student who has passed in Mathematics in his first and second years, but who later on manifests a weakness in any kind of Mathematical work that he is supposed to be familiar with, will likewise be subject to regular attendance at the Laboratory, by order of the Dean, till this weakness has been remedied.

MECHANICS.

Mech. 101.—Statics. Six hours recitation per week during Summer term. Prerequisites, Physics 2 and Math. 8. Resolution and composition of force, couples, center of gravity, cords and pulleys.

Mech. 102.—Statics. Five recitations per week for first two weeks. Continuation of Mech. 101.

Mech. 102.—Statics. Six recitations per week for first two week for last seven weeks. Prerequisites, Mech. 102. Application of the laws of statics to the various materials used in engineering structures.

Mech. 104.—Mechanics of Materials. Six hours recitation per week for first six weeks. Continuation of Mech. 103.

Mech. 105.—Dynamics. Six hours recitation per week for last three weeks. Prerequisite, Math. 102. The laws of moving bodies translation, rotation, friction, belts, work and energy.

Mech. 106.—Dynamics. Six hours recitation per week during Summer term. Continuation of Mech. 105.

Mech. 201.—Hydraulics. Three hours recitation and two hours laboratory per week. Prerequisite, Mech. 106. A study of the elementary principles of the mechanics of fluids, fluid pressure and rigid bodies, laws of flowing water and methods and means of measuring.

Mech. 301.—Engineering Materials. Three hours recitation per week. Prerequisites Math. 6, and Physics 2. A study is made of the properties and characteristics of materials used in engineering construction and the methods of manufacture of the same.

Mech. 302.—Testing of Materials. Four hours per week in the laboratory. Prerequisite, Mech. 103. Class tests to show methods of testing and the strength and general characteristics of various materials used in engineering construction.

Mech. 303.—Testing of Materials. Four hours per week in the laboratory. Prerequisite, Mech. 302. This is a continuation of Mech. 302 in which the student performs individual tests of the various engineering materials.

MODERN LANGUAGES.

French 1.—French. The work begins with oral exercises, and conducts the student through elementary grammar, including the more important irregular verbs; simple French prose should be understood and translated by the end of the year. Easy conversations are introduced.

French 2.—French. This course continues preceding work in grammar and syntax, and has for its object the free reading of standard prose; exercises in translation from English into French are frequently assigned. The purpose is to fit the student for wider professional reading.

German 1.—German. The easier grammatical forms, as far as the irregular verbs, are gone over, with translations and practical simple oral work.

German 2.—German. This course continues the work of German 1 in syntax and grammar, and by conversations, readings and themes prepares the student to read with some ease the standard German prose.

PHYSICS.

Physics 1.—Elementary Physics (With Laboratory). This is an elementary and descriptive course designed to give students a general idea of the principal phenomena and laws of physics. It is a prerequisite for Sophomores; and it is not given as a regular subject in the Freshman year of engineering, but is listed as an entrance requirement. Special students who lack this credit will be allowed to take this course in Freshman year.

Physics 2.—Mechanics, Molecular Physics and Heat. Prerequisite, Trigonometry and Physics 1. Four hour class. This course corresponds to the first half of general or college physics. It calls for a careful analysis of principles and laws, their development, their correlation, and their practical applications. Special attention is given to mechanics.

Physics 3.—Electricity, Sound and Light. Prerequisite, Physics 2. Four hours class. In the continuation of General Physics the same analytical method is pursued in the discussion of the theories which underlie the phenomena of these subjects, and due emphasis is placed on the important application of the mechanics of waves and harmonic motion to these phenomena.

Physics 3a.—Continuation of Physics 3 through the summer term.

Physics 6.—Advanced Physics. Mechanics and Heat. Prerequisites, Physics 2, 3; Mathematics 6, 7, 8. This course goes into the mathematical theories of these subjects as well as the refined methods of modern research; and due attention is given to practical applications in engineering and the industries generally.

Physics 7.—Advanced Physics II. Electricity, Light and Sound. The mathematical side of the subject is made prominent, and modern theories and methods are discussed from this standpoint. Practical applications receive due attention.

Physics 102.—Physical Measurements. Laboratory corresponding to Physics 2. Four laboratory hours. Quantitative determination of physical constants; adjustments and use of instruments of precision, such as the micrometer microscope, cathetometer, chronograph, etc. Verification of the laws of impact, of torsion and rigidity, of the composition of harmonic motions, of gravity; Young's modulus, Moment of Inertia, etc. Determination of specific heats, coefficients of expansion, laws of gases; hygrometry.

Physics 103.—Physical Measurements. Laboratory corresponding to Physics 3. Four laboratory hours. Experiments covering the laws of refraction, accurate measurements of indicies of refraction,

critical angle, magnifying power, photometry and spectrum analysis, interferometer. Electro-static induction; theory of condenser; measurement of resistance; efficiency of electric motor; operation of alternator and transformer pyrometry.

Physics 103a.—Physical Measurements. Four hours per week in laboratory. Laboratory corresponding to Physics 3a. It is a continuation of Physics 103.

Physics 106.—Measurements in Sound, Heat, Light. Prerequisites, same as Physics 6. A laboratory course, co-ordinates with Physics 6, in which accurate measurements are made in such phenomena as stationary waves, Lissajous' curves, etc., vapor tension. calorimetry; Spectrometer, diffraction, grating, polariscope, bi-prism, photometer and interferometer.

Physics 107.—Electrical Measurements. Prerequisites, Physics 3 and Math. 8. Four hours laboratory per week.

The development of electrical theories. The laboratory work includes the calibration of measuring instruments; resistance of conductors, electrolytes, dialectrics, magnetic properties of iron, magnetometer, self-induction, inductance and capacity, high and low potentials, conduction of electricity through gases.

PHILOSOPHY.

COURSE I. Logic. I; (4).

COURSE II. Psychology. I; (4).

COURSE III. Ethics. II; (4).

These courses are offered in the Arts and Sciences Department, but are open also to the Engineering Department.

COURSE IV. Business Ethics. I; II; (1).

This course will embrace the fundamental principles of right and wrong, of justice and injustice, together with the application of these principles to the many phases of industry, commerce and finance.

The purpose of the course is to develop and strengthen an intelligent business conscience.

COURSE V. Business Psychology. I, II; (1).

A course in practical psychology, including a study of the nature and development of the powers and mental faculties which make for character and efficiency.

MARQUETTE UNIVERSITY

MILWAUKEE, WISCONSIN

COLLEGE OF ARTS AND SCIENCES.*

Courses in Letters, Sciences and Philosophy, leading to the Bachelor's degree in Arts and Sciences.

COLLEGE OF APPLIED SCIENCE AND ENGINEERING*

Courses in Civil, Mechanical, Chemical and Electrical Engineering, leading to Professional Degrees.

NOW USING THE CO-OPERATIVE SYSTEM.

SCHOOL OF MEDICINE.

A seven-year course leading to the degree of Bachelor of Science and Doctor of Medicine.

COLLEGE OF LAW.*

a. The Day Law School, a four-year course leading to the degree of Bachelor of Laws.
b. The Evening Law School, a four-year course preparing for admission to the bar.

COLLEGE OF DENTISTRY.

A four-year course leading to the degree of Doctor of Dental Surgery.

THE R. A. JOHNSTON COLLEGE OF ECONOMICS.*

a. A three-year course leading to the degree of Bachelor of Commercial Science.
b. A four-year course leading to the degree of Bachelor of Science in Economics.

SCHOOL OF JOURNALISM.*

a. Four-year courses leading to the degrees of Bachelor of Arts in Journalism, Bachelor of Science in Journalism, and Bachelor of Literature in Journalism.
b. A three-year course leading to the degree of Bachelor of Journalism.

TRAINING SCHOOL FOR NURSES.

Conducted in connection with Trinity Hospital. A three-year course.

MARQUETTE UNIVERSITY CONSERVATORY OF MUSIC.

Instruction in Piano, Vocal, Violin, Organ and all orchestral instruments. Theory and History of Music, Dramatic Art, Art of Expression, Public School Music, Ensemble and Sight-Reading.

MARQUETTE ACADEMY.

The University High School.

Preparatory Department, Classical and Commercial courses, Courses preparatory to Law, Medicine and Engineering.

SUMMER SCHOOL.

Six weeks' session during July and August. College of Arts and Sciences.

*These Departments also have evening sessions.

PROFESSIONAL ETHICS.

In the engineering, as in the other professional schools of Marquette University, a course in professional ethics is deemed an essential part of the curriculum.

The need of sound principles of morality in all the professions is now quite widely recognized.

A physician, a lawyer, an economist, or an engineer whose moral development does not compare favorably with his mental equipment can never win the confidence of his fellow men. They look askance at him and deem his presence in the community a menace to the home and a source of fear to the state.

Marquette solves the problem that is occupying the minds of many leaders in the engineering profession. "The present-day problem in engineering education," to quote a prominent member of the faculty of an engineering college in Iowa, "is how to educate our engineers better in the fundamentals of successful education. High qualities of manhood are absolutely essential in the engineer; so are high technical qualifications. * * *

"The engineer must pass a double test and not fail in either manhood or technical requirements. * * *

"No person should be ranked as an engineer who does not possess the manhood qualifications in a satisfactory degree, and this requirement should be separate from and in addition to satisfactory technical qualifications."

The Faculty of Marquette University considers it necessary for the weal of the family and civil society to insist upon professional ethics for the engineering students.

MARQUETTE UNIVERSITY

COLLEGE OF APPLIED SCIENCE AND ENGINEERING

BULLETIN OF MARQUETTE UNIVERSITY
SERIES III. VOL. 6. NUMBER 3. MARCH, 1921.

ANNUAL CATALOGUE

COLLEGE OF ENGINEERING

1921-1922

PUBLISHED MONTHLY BY MARQUETTE UNIVERSITY
MILWAUKEE . . 1115 GRAND AVENUE . . WISCONSIN

ntered as SECOND CLASS Matter April 12th, 1916, at the Post Office at Milwaukee, Wisconsin, Under the Act of August 24th, 1912.

1921

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CALENDAR

1921—1922

Registration (Freshmen) ..... Sept. 5 to Sept. 7
Entrance Examinations ..... Sept. 8 to Sept. 10

	Sect. A	Sec. B
Registration (Upper Classmen)	Sept. 12	Sept. 26
Class work begins	Sept. 13	Sept. 27
Shop work begins	Sept. 26	Sept. 12
Thanksgiving recess	Nov. 10-12	Nov. 24-26
Holiday recess	Jan. 1-7	Dec. 25-31
First Term classes end	Jan. 14	Jan. 28
Second Term Registration	Jan. 30	Feb. 13
Second Term class work begins	Jan. 31	Feb. 14
Easter recess	Mar. 31-Apr 3	Apr. 14-17
Second Term classes end	May 27	June 10
Summer Term classes begin	May 30	June 12
Year closes	Sept. 9	Aug. 19
Vacation	July 31-Aug. 19	Aug. 21-Sept. 9

OFFICERS

REV. H. C. NOONAN, S. J. ..... President
J. C. PINNEY, A.B., C.E. ..... Dean
JOHN B. KREMER, S. J. ..... Faculty Regent
EUGENE RUDGE, S. J. ..... Treasurer
MARY L. MELZER ..... Registrar

FACULTY

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Professor of Ethics.

JAS. C. PINNEY, A.B., C.E.,
Dean of the College of Engineering.
Professor of Civil Engineering

JOHN B. KREMER, S. J.,
Faculty Regent.
Professor of Physics.

ROBERT N. BAUER, Ph.G., B.S.,
Professor of Chemistry.

W. D. BLISS, B.S. in Ch.E., M.E.,
Co-ordinator.
Professor of Mechanical Engineering.

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Professor of English.

A. F. FRUMVELLER, S. J., Ph.D.,
Professor of Mathematics.

GEORGE A. SCARCLIFF, B.S. in C.E.,
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JOSEPH F. CARROLL, S. J., A.M.,
Assistant Professor of Physics.

JOHN F. DOUGLAS, S. B., Ph.D.,
Assistant Professor of Electrical Engineering.

M. GILBERT, A.B.,
Assistant Professor of Chemistry.

PAUL MUEHLMANN, S. J., A.M.,
Assistant Professor of Mathematics.

AUGUSTINE D. THEISEN, S. J., A.M.,
Assistant Professor of Mathematics.

ANTHONY J. GAUCKLER, A.B., B.S. in C.E.,
Instructor in Civil Engineering.

JOAQUIN H. HERNANDEZ, B.S. in C.E.,
Instructor in Civil Engineering.

EDWARD W. KANE, B.S. in E.E.,
Instructor in Electrical Engineering.

H. B. KEIRSEY, B.S. in M.E.,
Instructor in Mechanical Engineering.

JUSTIN E. McCARTHY, A.B.,
Instructor in English.

CLIFTON E. McDONALD, A.B.,
Instructor in English.

NAND SINGH, M.E.,
Instructor in Chemistry.

H. M. STOCKDER, B.S. in M.E.,
Instructor in Mechanical Engineering.

HENRY B. BLECK,
Assistant Instructor in Surveying.

JOSEPH D. BONNESS,
Assistant Instructor in Mathematics.

GEORGE A. HERRMANN,
Assistant Instructor in English.

ALICE L. QUINN,
Secretary to the Faculty.

SPECIAL LECTURERS

S. J. GATES,
Gates Engineering Co.

T. CHALKLEY HATTON,
Chief Engineer of Milwaukee Sewerage Commission.

W. R. McGOVERN,
General Manager of Wisconsin Telephone Co.

I. C. WHEELER,
Erwin, Wheeler & Woolard,
Counselors at Patent Law.

DUDLEY CRAFTS WATSON,
Director of Milwaukee Art Institute.

DR. E. KIDWELL,
Kidwell Boiler & Engineering Co.

CO-OPERATING FIRMS

ALLIS-CHALMERS MFG. CO.

AVERY CO.

BRIGGS & STRATTON CO.

BUCYRUS MFG. CO.

CHAIN BELT CO.

CUTLER-HAMMER MFG. CO.

C., M. & ST. P. R. R.

DAHLMAN CONSTRUCTION CO.

THE FALK CO.

FEDERAL RUBBER CO.

HARTMAN CONSTRUCTION CO.

KEMPSMITH MFG CO.

LAKESIDE BRIDGE AND STEEL CO.

MITCHELL MOTOR CO., RACINE, WIS.

NASH MOTORS CO.

NATIONAL BRAKE AND ELECTRIC CO.

NORDBERG MFG. CO.

NORTHWESTERN BRIDGE AND IRON CO.

PAWLING AND HARNISCHFEGER CO.

RICHARDSON-PHOENIX CO.

H. SCHMITT AND SON, INC.

THE MILWAUKEE ELECTRIC RAILWAY AND LIGHT CO.

VILTER MFG. CO.

WISCONSIN BRIDGE AND IRON CO.

WISCONSIN MOTOR MFG. CO.

WORDEN-ALLEN CO.

THE TREND TOWARD THE ENGINEER

The vast industrial expansion of the present age has caused a marked change in the status of the engineer. It has been but few years since his position was primarily that of the theorist; the physical truths underlying engineering problems were supplied by him but the carrying out of those problems was usually left to other hands. The engineer is no longer the theorist alone; he is an important factor in constructive, industrial and executive fields. He no longer merely points the way; he is carrying these problems to a successful completion. His position today has been aptly defined as that of a man who can economically direct the forces of nature, including human nature to the use and benefit of mankind.

The transition of the engineer from the position of the theorist to the one he holds today has not in any measure carried him to the point where he may be classed as the technician. The difference between the engineer and technician is between the man who has mastered all rather than part of his subject.

Engineering education should be such as to train the man not as a theorist alone, not as a technician, but rather to meet successfully the position he must occupy today. A school that trains the man merely as a technician has its field but has no classification among engineering educational institutions. The school that trains him along theoretical lines wholly or in the main, has a sound classification among such institutions, but the question arises, is the training in itself sufficient? The answer is plainly, no. After completing such an education the young man is in a position to assume the responsibilities of engineering problems of today, only upon the completion of an apprenticeship of several years in practical work.

Investigations conducted by some of our leading educators have indicated, and results obtained by the inauguration of the Co-operative System have proven that the practical, as well as the theoretical training required of the engineer today can best be obtained through the medium of an engineering college. Results have clearly proven the wisdom of the Co-operative System of engineering education, and a thorough study of its merit can only disclose the distinctive value of such a training.

We are living today in the industrial age. The leading figure of the industries is the engineer. The demand for his services is more distinctly increasing at the present time than ever before. The young man entering such a training is not confronted with a restricted field but an ever growing one. Given an inclination along this line, coupled with the needed aggressiveness, he can make no mistake in embarking in the field of engineering.

THE CO-OPERATIVE COURSE IN ENGINEERING

The Co-operative Idea:

Co-operative education means the active participation of industries in the training of technical men. It represents the collective efforts of educators and employers to develop engineers who can better cope with the industrial problems of today because of actual personal contact with existing conditions in industry.

The co-operative plan is not an experiment. Its success has been fully demonstrated at the University of Cincinnati by fourteen years of operation. Since the adoption of this plan at Marquette University, other technical schools have introduced it, among them the Massachusetts Institute of Technology.

The Plan of Co-operation:

The students are divided into two groups termed Section A and Section B. The members of Section A attend school for two weeks, while members of Section B are employed at the various industries in and about Milwaukee. At the end of a two-week period Section B reports to school and Section A to work. This alternation in periods of two weeks is carried on throughout the year.

Arrangements for employment are all made by the school and the nature of the work depends largely upon the student's course of study in the University. While at work the student is in every sense an employee of the co-operative firm, subject to the firm's rules, regulation and hours, and the orders of its foremen in every respect.

The school maintains close contact with each student's progress in the industries by means of a co-ordination department. This department is the connecting link between the industries and the school and all matters of employment are referred to it.

The Industries:

A variety of industries is vital to the Co-operative Plan. Few cities in America are as fortunate in this respect as Milwaukee. Many of the largest industries of their kind are located here. The Bucyrus Company makes excavating machinery. Its products can be seen on nearly every large construction project in America. The Allis-Chalmers Mfg. Co. builds steam turbines, gas engines, oil engines, hydraulic machinery, cement and mining machinery and many kinds of electrical equipment. These products go to every part of the world.

The ships of the U. S. Navy are equipped with reduction gears built by the Falk Co. The Cutler-Hammer Mfg. Co. is the largest builder of electrical controlling devices in America. The National Brake & Electric Co. makes electrical machinery, air brakes, and gas-

oline locomotives. The Nash Motors Co. build a four-cylinder car here, and opportunity is afforded Marquette students to learn every phase of automobile construction.

The field of public utilities includes the local Traction Company, the Coke & Gas Works, the Telephone Company and two Railroads. Builders of electric cranes, bridges and general structural products include the Pawling & Harnischfeger Co., the Worden-Allen Co., Lakeside Bridge & Steel Co. and the Wisconsin Bridge Co.

The field of building construction is well provided for in a large city where many municipal and private projects are under way. Practically all of the large contractors find employment for Marquette students during the building season.

Road building is another important field for Civil Engineering students and Wisconsin is spending millions of dollars each year on this work.

More than thirty of Milwaukee's largest industries are co-operating with the College of Engineering of Marquette University.

Schedules of Work:

In the co-operative industries where Chemical, Electrical or Mechanical Engineering students are employed work schedules have been laid out, by these firms, which are calculated to give in two and one-half years the practical experience most essential to engineers in that particular industry. These schedules are intended as a general working plan only since the amount of time spent in various departments of a plant depends largely upon the individual student's ability and aptitude for practical shop work.

In general, considerable time is devoted to the basic operations of a manufacturing plant, such as: foundry work, machine tool operation, assembly of the product, and test. Draughting room experience is offered to men who wish to become designers.

The plan for Civil Engineering students is necessarily more elastic since the work after one year is mostly seasonal in character. Civil Engineers are required to spend approximately one year in structural steel shops at the beginning of their course. They then enter various fields such as railway engineering, municipal improvement projects, building and bridge construction, road construction, surveys, etc.

Compensation of Co-operative Students:

While the object of this system is purely educational, and the work for each student is so chosen as to give him a thorough knowledge of his particular branch of the profession, nevertheless the compensation received from his shopwork may often be the means of enabling a young man to complete his schooling. While the student

is employed, as before stated, he is in every respect an employee of the firm for which he is working. He receives compensation for his work and such compensation is paid directly to him. The University necessarily cannot control completely the wages paid to its students. A minimum hourly rate has been agreed upon with co-operating industries which is considerably above the rate paid to regular shop apprentices. The amount a student may earn above this minimum rate depends, in general, upon the class of work and upon his ability. It will average about $350 per year at the present rates. It is well to point out here that nothing could so surely destroy the benefits of the co-operative plan as an effort on the part of the University to secure for its students the maximum rate of pay for any particular class of work. Experience has shown that where such maximum rates prevail the idea of educating the student and advancing him from one class of work to another is entirely lost sight of, and that in times of industrial depression the students are immediately laid off along with other high priced help.

The Course:

It is evident that when the student spends one-half of his time in school and the other half in employment, he is unable to cover all of the theory and application of the four year academic course in an equal length of time. The Co-operative Course at Marquette University does cover the same academic ground as that of the average standard Engineering College. It extends over a period of five years, four years of forty-eight weeks each and one year of forty weeks. The first four years are divided into two terms of twenty weeks each and a summer term of eight weeks. There is a vacation period of three weeks between the school years and a recess of one week during the school year. The last year is made up of two semesters of twenty weeks each. The recesses occur consecutively and not simultaneously for the two sections of the student body. This program has made it possible to cover all the fundamentals which both educators and practicing engineers agree are essential for the proper training of engineering students.

Advantages of the Co-operative Course:

It is believed pertinent to set forth here some of the reasons why the co-operative plan has taken so prominent a place in our system of engineering education.

The success of an engineer depends both upon his theoretical knowledge and on his ability to select the most efficient means for the economical solution of his problems. The latter involves not only the proper selection of material and machinery, but also the proper and efficient handling of men, who are needed in greater or smaller num-

bers to carry out a project. In order to accomplish this to the satisfaction of the men and the employer, the engineer must be familiar with the manners and habits of the workmen, with their way of looking at things, and at times be able to convince them that his method is right and their method is wrong. He must be able to gain their confidence by proving to them that he is perfectly familiar with the work they are expected to do.

There is no short cut to this kind of knowledge. Only by associating with the workers and by sharing their problems can the engineer hope to become a leader. Shop training to be effective must be started early in life and should be a recognized part of engineering education.

The attitude of employers regarding this sort of training was very well expressed by Mr. Charles Gingrich of the Cincinnati Milling Machine Co., some years ago. Speaking to the Society for the Promotion of Engineering Education, he said:

"We have all tried to give a shop training to young men from the colleges, but it is never entirely successful. A man who has put in four years of his young manhood getting a university education can not get into the shop atmosphere, even if he does don overalls and work as a regular hand. Such men have passed beyond the age at which boys ask questions and learn quickly all those little details which are such an important part of the training and experience of shopmen. They feel that they can not afford to be laughed at. They do not want to expose their ignorance. Therefore they get at best only a superficial knowledge of what is going on inside the shop. I do not mean to imply that our shops are full of secrets, but I do want to emphasize the fact that they contain a vast number of things to be learned; that the only place to learn them is in the shops; and that the best way to do it is to start young and take plenty of time. The chief criticisms of modern technical education result from the fact that we try to take the shop into the school, whereas we should bring the school into the shop. The co-operative plan does bring the school into the shop."

The objection raised by some educators that such intimate contact with the industries would tend to lower the scholastic standards has not been verified by experience. On the contrary, the co-operative system tends to build character and to broaden the student's outlook upon life through responsibilities that must be assumed at his place of employment. Experience at Marquette has clearly shown that these influences give students a better idea of the value of an education and their increased interest has been commented upon by every department of the school.

The system is selective since men who are unfitted for practical work soon drop out. One of the criticisms leveled at our old school

system is that many men spend four years acquiring an engineering education only to learn upon entering the practical field that they have chosen the wrong profession.

While it requires five years to complete the co-operative course, it must be remembered that many firms insist upon at least a two year apprentice course in their industry for men who have completed a four year course in engineering. This, in effect, extends their education to a period of six years, so there is a positive advantage from the standpoint of time alone.

It is but natural for an employer to fill vacancies in his organization by men who are personally known to him or to his subordinates. A student's record over a period of five years speaks for itself. It is clear that students, who have proven themselves valuable to any organization over that period of time, will be urged to remain. In any event, a good record of experience with a well-known company is certainly a valuable asset.

EQUIPMENT

The College of Applied Science and Engineering is well supplied with laboratories for all of the courses offered. These have been equipped in each case with the necessary apparatus, machinery, etc., for the conduction of theoretical and practical tests and investigations. They are being added to yearly, it being the aim of this College to keep them at a point of practical efficiency and of such extent as to keep pace with their increasing requirements. Included amongst these are the Chemical, Physical, Mechanical, Electrical, Materials Testing, Heat Treating laboratories; the machine shops, the Astronomical observatory, and the Topographic Engineering equipment. Only a brief description will be given here, rather than a detailed list of each individual piece of apparatus in each.

The Chemical Laboratory occupies the entire fourth floor of the Administration building, while that for Physics occupies the entire third floor of the same building. Both of these laboratories are equipped in minute detail for tests and investigations not only in the elementary courses but in the most advanced courses as well. Both have attendant lecture halls equipped for demonstrations.

The Mechanical Engineering Laboratory is located on the lower floor of the Engineering building. The equipment consists of high and low speed Corliss engines, gasoline and kerosene engines, pumps, condenser, air compressor, etc. Standard tests of steam and gas engines to obtain efficiency, power, performance, fuel consumption, as well as tests for quality of steam, fuel analysis, calibrating gauges, boiler tests, etc., are regularly conducted.

The Electrical Laboratory is similarly equipped with various types of generators, motors, transformers, converters, rectifiers and the

various other electrical appliances for making performance, efficiency and compromise tests, etc., with both Direct and Alternating current.

The Materials Testing Laboratory has testing machines for compression, tension and transverse loading tests up to a capacity of 200,000 lbs. It is also equipped with beam testing apparatus, extensometers, etc.; tensile testing machine for concrete; all necessary apparatus for the standard and commercial tests of concrete; calorimeter.

The Heat Treating Laboratory is equipped with gas and electric furnaces, cyanide and quenching baths, pyrometers, polishing apparatus, etc. Hardness tests can be made by both Brinell and Shore methods. Micro-photographs of properly prepared specimens can be taken. The equipment allows for the heat treatment and investigation of iron and steel and their alloys.

The Machine shop, consisting of lathes, shapers, milling machines, surface and cylindrical grinders, drilling machines, etc., is used for purposes of practical instruction and the building of special equipment for use in various departments. It is also possible with this as a medium to conduct time study tests and so augment courses in production engineering and industrial management.

The Astronomical Observatory is located in the Administration building and is well equipped for the ordinary observations and for student practice and study.

The Topographic Engineering equipment consists of a large assortment of Dumpy and Wye levels, transits, compass, plane table, tapes, leveling and stadia rods, and other accessories used in Plane and Advanced Surveying.

LIBRARY FACILITIES

The Library of the College of Applied Science and Engineering includes the current issues of our standard technical magazines, the bound volumes of same for a period of several years and many reference and hand books on various engineering subjects. The additional library facilities afforded, those of the University and City Libraries, are so extensive that they present an almost unlimited field for special study and investigation.

The University Library contains 13,000 volumes and its circulation department, open to the student twice a week, affords an opportunity for intimate association with many standard works. The subjects represented are of general educational value.

The magnificent public library of the city of Milwaukee is three blocks distant from the College of Engineering. The main library together with its eight branches contains 325,000 volumes. The interior arrangement of the library is an ideal one for the student; he has access to all the books for consultation and study, and with proper permit may take them home with him.

The Science room alone has a total of 25,000 volumes. Almost any book desired covering such subjects as Natural Science, Mathematics, Physics, Electricity, Chemistry, Geology, and the applied subjects in the major branches of engineering can be obtained here.

In connection with the library there is a museum containing one of the largest mineralogical collections in the United States, affording an excellent opportunity for intimate study of rock specimens to students in Chemistry, Geology, etc.

INFORMATION

For information concerning the College of Applied Science and Engineering address the Registrar, 1115 Grand Avenue. Interested persons are urged to call at the Registrar's office whenever possible, since personal interviews are much more satisfactory than correspondence.

REGISTRATION

The office of the Registrar, first floor of the Administration building of Marquette University, 1115 Grand Avenue, is open daily from 9-12 A. M., 2-5 P. M., with the exception of Saturday afternoons, Sundays and holidays. At registration time it is also open on Saturday afternoons.

The dates of registration for students in Engineering will be found in the Calendar.

Students are required to register at the specified time.

ENTRANCE REQUIREMENTS

Applicants for admission must present a certificate from the principal of an accredited high school, a transfer from some institution in which he has taken advanced work or be subject to the entrance examinations of this College.

All candidates for a degree must present entrance credits amounting to fifteen units. A unit represents a year's study in a high school subject pursued five times a week.

All students entering this College can do so only under one of the following classifications:

1.—(a) Students who have 15 units from an accredited high school.

(b) Students who have passed the entrance examinations. This includes men who have obtained their preliminary training in an unaccredited high school or in any other manner and have been able to pass the entrance examinations.

2.—Conditioned students. Those who lack one, or at the most two units for admission, may be admitted with the condition that they pass the entrance examination in the subject in which they were deficient, within one year of entrance.

3.—Special students. Students who do not have enough credits to be classed as conditioned, and who cannot pass the entrance examinations, may be accepted as special students, provided they are above 21 years of age, the limiting age for high school students. Such students can become candidates for a degree only upon the satisfactory completion of their entrance credits.

4.—Unclassified students. Those who take only part of the courses offered. These men are not candidates for a degree.

UNITS REQUIRED FOR ADMISSION

The following units are those required of all students who are candidates for a degree:

Algebra (through Quadratics) 1½	English Literature..... 1
Plane Geometry 1	History 1
Solid Geometry ..... ½	Elemen. Physics or
English Composition..... 1	Elemen. Chemistry..... 1
	Electives 8

ELECTIVE UNITS

The elective subjects that may be presented to complete the required units must be taken from the following list:

English	1 to 2 units
Spanish, French, German	1 to 2 units
Latin, Greek	1 to 2 units
Mathematics	1 unit
Ancient History	1 unit
Medieval and Modern History	1 unit
English History	1 unit
United States History	1 unit
Science (Not more than a total of 4 units)	
Biology	1 unit
Botany	1 unit
Chemistry	1 unit
Physical Geography and Geology	1 unit
Zoology	1 unit
Physiology	½ unit
Vocational and Miscellaneous	4 units

Vocational and Miscellaneous Subjects, such as Drawing, Commercial Law, Commercial Geography, Bookkeeping and Manual Training, are accepted only when the student presents, in addition to a full account of number of class hours spent in each, specimens of the work done.

Not more than four units will be accepted in any one subject.

No Collegiate credit is given for high school work.

Due credit will be given for advanced work done at other Universities and Colleges of accepted standing upon the proper transferal of these credits, provided the nature of the work covered is similar enough to be considered the equivalent of the course offered in this College.

EXPENSES

A matriculation fee of $10.00 is charged every student when he decides to enter the University. This is charged but once and is not an annual fee.

An annual athletic fee of $10.00. This admits him to local athletic contests.

*Annual gymnasium fee of $5.00.

An annual fee of $5.00 for the Marquette Union. This is for the support of club house and student activities.

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*This fee will not be claimed if the new gymnasium is not ready for use by October 1, 1921. In case of its being opened later than October 1, the fee will be announced at the date of opening.

General tuition fee of $150.00 per year, payable $75.00 at registration of first term, and $75.00 at second term registration.

No student will be admitted to classes until the fees for the current semester are paid. No exception will be made and students should come prepared. Tuition fees once paid cannot under any circumstances be returned. Tickets cannot be transferred. Matriculation fees once paid cannot be returned or transferred. Students agree to these conditions when paying fees.

Chemistry breakage deposit of $10.00 per year. Partly returnable, dependent upon amount of breakage. Payable only those years when Chemistry is taken.

Laboratory fees of $2.50 per term per credit hour is charged for all laboratory and field courses.

Books and drawing instruments will cost from $40.00 to $50.00 for the Freshman year, depending upon the quality of instruments purchased. Thereafter the cost is approximately $25.00 per year.

Dues of the Engineering Society are $2.00 per year.

Board and room can be obtained in close proximity to the University at from $8.00 to $11.00 per week.

The student should also make due allowance for sundry personal expenses such as laundry, social activities, etc.

The average yearly return to the student from his co-operative employment is approximately $350.00. In general this is about 55 per cent of the total cost to the student.

ACADEMIC RULES AND REGULATIONS

Every student shall carry a minimum of 12 credit hours' work prescribed for the class in which he registers; otherwise he is classed as a special.

A final average below 60 for a term's work in any subject is a failure. The student will be required to repeat the work at the earliest opportunity and will not be allowed to take advanced work in the same subject or in a subject dependent upon it until he shall have made up his failure.

A final average between 60 and 70 conditions the student. A condition must be removed before the next regular offering of the subject or it becomes a failure. It will not, however, prevent the student from pursuing the advanced work. Examinations for conditions are offered in January, June and September. The student is held responsible for arranging to remove his condition. He must register for same and pay a fee of $1.00; for special condition examinations the fee is $2.00.

A final average above 70 entitles the student to credit in that subject. Credit may be withdrawn in case his subsequent work shows lack of necessary understanding, and he may be required to take such special work or repeat such sections of the subject as the Dean may prescribe.

Failure to complete certain assignments in a given subject within the prescribed time will cause an Incomplete to be granted for that subject. Failure to complete the work by the end of the succeeding term changes the Incomplete to a failure.

Reports are sent to Parents or Guardians at regular intervals regarding the student's standing and progress.

Failure to obtain a passing grade in one-half of the work for any one term results in a condition of probation for the succeeding term. At the end of the probation period, if he is still below passing grade in one-half of his work, the student will be dropped from the school.

Absences from class without sufficient reason are not tolerated. Upon presentation of proper reasons, the student is granted a written excuse for absence. In the case of more than 10 per cent of unexcused absences, final grade in the subject is withheld.

A change from one branch of engineering to another will only be allowed upon written application to the Dean at least one month before the close of a school term, stating clearly the reasons for desiring to make the change.

Freshmen and Sophomore students desiring to elect a subject may do so only when they have attained an average grade of 85 per cent for the preceeding term's work, with no one mark below 80 per cent, or to complete a regular schedule in the case of conflict with the regular schedule of studies for the term.

An assessment of $3.00 will be charged for tardy registration.

Students allowed to carry more than 22 credit hours of work will be assessed at the rate of $2.50 per credit hour in excess of this number, unless such fee is paid to some other department of the University.

SHOP RULES AND REGULATIONS

Absences from shop are not tolerated. Students violating this ruling will be dealt with sternly. In the case of unavoidable absence such as severe sickness, the student must see that both the shop and the Co-ordinator of the school are notified of same on the first day of absence. On the first day of his return to work, the student must obtain a written excuse signed by the foreman and one other official at the place of employment and forward immediately to Co-ordinator. Violation of this ruling will lead to dismissal from school.

Students are subject to all rules of the shop where employed.

Unsatisfactory work in the shop is regarded by the faculty in the same light as poor work in the class room and can likewise lead to dismissal.

Leaving a place of employment or school for any reason whatsoever without the permission of both the shop and school officials places the student subject to dismissal from school and withdrawal of the year's credits.

Vacations, other than the regular shop holidays, are at all times forbidden.

Dissatisfaction with employment or any phase of it must be taken up with the Co-ordinator of the school. If this rule is judiciously adhered to, in practically every case the difficulties can be removed.

DEGREES

The University grants the professional degrees of Chemical Engineering (Ch.E.), Civil Engineer (C.E.), Electrical Engineer (E.E.), and Mechanical Engineer (M.E.), to students who have successfully completed the five-year co-operative course in any of the respective branches.

SCHEDULE OF COURSES
CHEMICAL ENGINEERING

Note.—One credit hour is the equivalent of one hour of recitation or two hours of laboratory or field work per week for nine weeks.

FIRST YEAR

		Hrs. per wk. Rec.	Lab.	Cr. Hrs.
First Term				
Math. 30	Advanced Algebra	6		6
Chem. 1	General Chemistry	3	4	5
Eng. 20	English and Pub. Speaking	3		3
Draw. 10	Engineering Drawing		6	3
G. E. 70	Elementary Engineering		2	1
C. 90	Co-ordination		2	1
Second Term				
Math. 31	Trigonometry	6		6
Chem. 2	General Chemistry	3	4	5
Eng. 21	English and Pub. Speaking	3		3
Draw. 11	Engineering Drawing		4	2
C. E. 210	Elementary Surveying		4	2
G. E. 71	Elementary Engineering		2	1
C. 91	Co-ordination		2	1
Summer Term				
Chem. 3	Qualitative Analysis		12	3
Draw. 12	Engineering Drawing		10	2
C. E. 211	Elementary Surveying		12	3

SECOND YEAR

First Term				
Math. 32	Analytical Geometry	6		6
Phys. 50	Mech., Molec. Phys. and Heat	4		4
Draw. 13	Descriptive Geometry	2	6	5
Phys. 51	Physical Measurements		4	2
Ch. E. 120	Metal. of Iron and Steel	2		2
C. 92	Co-ordination and English		2	1
Second Term				
Math. 33	Differential Calculus	5		5
Chem. 4	Quantitative Analysis		4	2
Phys. 52	Elec., Sound and Light	4		4
Phys. 53	Physical Measurements		4	2
M. E. 425	Heat Engines	3		3
Ch. E. 121	Metal. of Iron and Steel	2		2
M. E. 421	Mechanical Engr. Lab.		4	2
C. 93	Co-ordination and English		2	1

(Chemical Engineering)

Summer Term		Hrs. per wk. Rec.	Lab.	Cr. Hrs.
Mech. 40	Statics	6		3
Ch. E. 122	Fuel and Gas Analysis		8	2
M. E. 426	Heat Engines	2		1
Phys. 54	Elec., Sound and Light	5		2
Phys. 55	Physical Measurements		4	1
First Term	**THIRD YEAR**			
Math. 34	Integral Calculus	5		5
Chem. 5	Quantitative Analysis		8	4
Mech. 41	Stat. and Mech. of Materials	6		6
M. E. 432	Mechanical Eng. Lab.		4	2
C. 94	Co-ordination and English		2	1
Second Term				
Mech. 42	Mech. of Mater. and Dynamics	6		6
M. E. 435	Mechanism	2	6	5
Ch. E. 130	Inorganic Tech. Analysis		4	2
E. E. 370	Elements of Elec. Engr.	4		2
E. E. 371	Elec. Eng. Laboratory		4	2
C. 95	Co-ordination and English		2	1
Summer Term				
Mech. 43	Dynamics	6		3
Ch. E. 132	Iron and Steel Analysis		12	3
Ch. E. 131	Inorganic Tech. Analysis		8	2
First Term	**FOURTH YEAR**			
Ch. E. 140	Applied Electro Chem.	2	4	4
Chem. 6	Organic Chemistry	3	4	5
Mech. 44	Hydraulics	4		4
E. E. 373	Elements of Elec. Engr.	4		4
M. E. 440	Machine Design		8	4
C. 96	Co-ordination and English		2	1
Second Term				
Ch. E. 141	Applied Thermal Chem	3		3
Chem. 7	Organic Chemistry	3	4	5
Ch. E. 142	Metallography	2	4	4
Mech. 46	Engineering Materials	3		3
Mech. 47	Test. Materials Lab.		4	2
E. E. 334	Electrical Engr. Lab.		4	2
C. 97	Co-ordination and English		2	1
Summer Term				
Ch. E. 143	Organic Tech. Analysis		16	4
C. E. 243	Structural Design		16	4

FIFTH YEAR—(Chemical Engineering)

First Term		Hrs. per wk. Rec.	Lab.	Cr. Hrs.
Ch. E. 150	Organic Tech. Analysis		8	4
Ch. E. 151	Heat Treat. of Steel		8	4
M. E. 450	Industrial Management	3		3
G. E. 72	Economics	3		3
C. 98	Co-ordination and English		2	1
	*Electives			5
Second Term				
Chem. 8	Physical Chemistry	2	4	6
Ch. E. 152	Industrial Chemistry	5		5
M. E. 451	Industrial Management	3		3
G. E. 73	Economics	3		3
C. 99	Co-ordination and English		2	1
	*Electives			4

* Choice of electives is subject to the approval of the head of this Department.

CIVIL ENGINEERING

FIRST YEAR

First Term		Hrs. per wk. Rec.	Lab.	Cr. Hrs.
Math. 30	Advanced Algebra	6		6
Chem. 1	General Chemistry	3	4	5
Eng. 20	English and Pub. Speaking	3		3
Draw. 10	Engineering Drawing		6	3
G. E. 70	Elementary Engineering		2	1
C. 90	Co-ordination		2	1
Second Term				
Math. 31	Trigonometry	6		6
Chem. 2	General Chemistry	3	4	5
Eng. 21	English and Pub. Speaking	3		3
Draw. 11	Engineering Drawing		4	2
C. E. 210	Elementary Surveying		4	2
G. E. 71	Elementary Engineering		2	1
C. 91	Co-ordination		2	1
Summer Term				
Chem. 3	Qualitative Analysis		12	3
Draw. 12	Engineering Drawing		10	2
C. E. 211	Elementary Surveying		12	3

SECOND YEAR—(Civil Engineering)

First Term		Hrs. per wk. Rec.	Lab.	Cr. Hrs.
Math. 32	Analytical Geometry	6		6
Phys. 50	Mech., Molec. Phys. and Heat	4		4
Phys. 51	Physical Measurements		4	2
Draw. 13	Descriptive Geom.	2	6	5
Ch. E. 120	Metal. of Iron and Steel	2		2
C. 92	Co-ordination and English		2	1
Second Term				
Math. 33	Differential Calculus	5		5
Phys. 52	Elec., Sound and Light	4		4
Phys. 53	Physical Measurements		4	2
C. E. 220	Plane and Topogr. Survey	3	4	5
M. E. 425	Heat Engines	3		3
C. 93	Co-ordination and English		2	1
Summer Term				
Mech. 40	Statics of Mechanics	6		3
Phys. 54	Elec., Sound and Light	5		2
Phys. 55	Physical Measurements		4	1
C. E. 221	Plane and Topogr. Survey		8	2
M. E. 426	Heat Engines	2		1

THIRD YEAR

First Term				
Math. 34	Integral Calculus	5		5
Mech. 41	Stat. and Mech. of Materials	6		6
C. E. 230	Advanced Surveying	3	6	6
M. E. 434	Mech. Engr. Laboratory		4	2
C. 94	Co-ordination and English		2	1
Second Term				
Mech. 42	Mech. of Materials and Dynamics	6		6
C. E. 235	Theory of Structures	5		4
C. E. 231	Railroad Curves	3		3
E. E. 370	Elem. of Electrical Engr.	4		4
E. E. 371	Electrical Engr. Lab.		4	2
C. E. 232	Railroad Location		2	1
C. 95	Co-ordination and English		2	1
Summer Term				
C. E. 236	Theory of Structures	5		2
Mech. 43	Dynamics of Mechanics	6		3
C. E. 233	Railroad Location		16	4

FOURTH YEAR—(Civil Engineering)

First Term		Hrs. per wk. Rec.	Lab.	Cr. Hrs.
Mech. 44	Hydraulics	4		4
G. E. 72	Economics	3		3
C. E. 240	Structural Design		8	4
C. E. 244	Theory of Reinfor. Concrete	3		3
E. E. 373	Elements of Elec. Engr.	4		4
E. E. 374	Electrical Engr. Lab.		4	2
C. 96	Co-ordination and English		2	1
Second Term				
Mech. 46	Engineering Materials	3		3
Mech. 47	Materials Testing Lab.		4	2
G. E. 73	Economics	3		3
C. E. 248	Rail. Constr. and Maintenance	3		3
C. E. 241	Structural Design		8	4
C. E. 249	Hydrology	3		3
C. E. 245	Theory of Rein. Concrete	2		2
C. 97	Co-ordination and English		2	1
Summer Term				
C. E. 242	Structural Design		12	3
C. E. 247	Rein. Concrete Design		12	3
C. E. 246	Theory of Rein. Concrete	5		2

FIFTH YEAR

First Term				
C. E. 253	Highways	4		4
C. E. 255	Reinforced Concr. Design		4	2
C. E. 250	Public Water Supply	3		3
C. E. 254	Foundations	3		3
Mech. 48	Materials Test. Lab.		4	2
C. 98	Co-ordination and English		2	1
	*Electives			5
Second Term				
C. E. 257	Bridge Design		12	6
G. E. 74	Contracts and Specific.	3		3
C. E. 251	Sewerage	3		3
G. E. 84	Geology	3		3
C. E. 256	Concrete Arch Design		6	3
C. 99	Co-ordination and English		2	1
	*Electives			2

* Choice of electives is subject to the approval of the Head of this Department.

ELECTRICAL ENGINEERING

FIRST YEAR

		Hrs. per wk. Rec.	Lab.	Cr. Hrs.
First Term				
Math. 30	Advanced Algebra	6		6
Chem. 1	General Chemistry	3	4	5
Eng. 20	English and Pub. Speaking	3		3
Draw. 10	Engineering Drawing		6	3
G. E. 70	Elementary Engineering		2	1
C. 90	Co-ordination		2	1
Second Term				
Math. 31	Trigonometry	6		6
Chem. 2	General Chemistry	3	4	5
Eng. 21	English and Pub. Speaking	3		3
Draw. 11	Engineering Drawing		4	2
C. E. 210	Elementary Surveying		4	2
G. E. 71	Elementary Engineering		2	1
C. 91	Co-ordination		2	1
Summer Term				
Chem. 3	Qualitative Analysis		12	3
Draw. 12	Engineering Drawing		10	2
C. E. 211	Elementary Surveying		12	3

SECOND YEAR

First Term				
Math. 32	Analytical Geometry	6		6
Phys. 50	Mech., Molec. Phys. and Heat	4		4
Phys. 51	Physical Measurements		4	2
Draw. 13	Descriptive Geometry	2	6	5
Ch. E. 120	Metal. of Iron and Steel	2		2
C. 92	Co-ordination and English		2	1
Second Term				
Math. 33	Differential Calculus	5		5
Phys. 52	Elec., Sound and Light	4		4
Phys. 53	Physical Measurements		4	2
Ch. E. 121	Metal. of Iron and Steel	2		2
M. E. 420	Heat Engines	6		6
M. E. 421	Mechanical Engr. Lab		4	2
C. 93	Co-ordination and English		2	1
Summer Term				
Phys. 54	Elec., Sound and Light	5		2
Phys. 55	Physical Measurements		4	1
Ch. E. 122	Fuel and Gas Analysis		8	2
Mech. 40	Statics	6		3

THIRD YEAR—(Electrical Engineering)

First Term		Hrs. per wk. Rec.	Lab.	Cr. Hrs.
Math. 34	Integral Calculus	5		5
Mech. 41	Stat. and Mech. of Materials	6		6
Phys. 59	Electrical Measurements		4	2
M. E. 432	Mechanical Engr. Lab.		4	2
E. E. 330	Elements of Elec. Engr.	4		4
E. E. 331	Electrical Engr. Lab.		4	2
C. 94	Co-ordination and English		2	1
Second Term				
Math. 35	Differential Equations	2		2
Mech. 42	Mech. of Mater. and Dynamics	6		6
E. E. 333	Elements of Elec. Engr.	4		4
E. E. 334	Electrical Engr. Lab.		4	2
M. E. 435	Mechanism	2	6	5
C. 95	Co-ordination and English		2	1
Summer Term				
Mech. 43	Dynamics	6		3
E. E. 336	Elec. Motor Applications	5		2
E. E. 338	Elem. Elec. Computations		6	1
E. E. 339	Elec. Mach. and Apparatus	3		1

FOURTH YEAR

First Term				
Mech. 44	Hydraulics	4		4
G. E. 72	Economics	3		3
G. E. 75	Principles of Accounting	3		3
E. E. 340	Elec. Mach. and Apparatus	4		4
E. E. 342	Electrical Problems		2	1
E. E. 341	Electrical Engr. Lab.		4	2
E. E. 343	Illumination	3		3
C. 96	Co-ordination and English		2	1
Second Term				
Mech. 46	Engineering Materials	3		3
Mech. 47	Materials Testing Lab.		4	2
G. E. 73	Economics	3		3
G. E. 77	Principles of Accounting	3		3
E. E. 345	Elec. Mach. and Apparatus	4		4
E. E. 347	Electrical Problems		2	1
E. E. 346	Electrical Engr. Lab.		4	2
E. E. 344	Illumination	3		3
C. 97	Co-ordination and English		2	1

(Electrical Engineering)

Summer Term		Hrs. per wk. Rec.	Lab.	Cr. Hrs.
C. E. 243	Structural Design		16	4
E. E. 348	Electrical Problems		6	1
E. E. 349	Elec. Power Distrib.	5		2
First Term	**FIFTH YEAR**			
G. E. 78	Commercial Law	2		2
E. E. 350	Electric Power Stations	5		5
E. E. 351	Telephone Engineering	5		5
E. E. 352	Theory of Elec. Design	3		3
E. E. 353	Electrical Design		4	2
M. E. 450	Industrial Management	3		3
C. 98	Co-ordination and English		2	1
Second Term				
G. E. 79	Commercial Law	2		2
G. E. 83	American Government	3		3
E. E. 355	Electric Railway Engr.	5		5
E. E. 354	Electrical Design		4	2
M. E. 451	Industrial Management	3		3
C. 99	Co-ordination and English		2	1
	*Electives			5

On approval of the Head of the Department another fifth year subject may be substituted for one of the above topics.

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* Choice of electives is subject to the approval of the Head of this Department.

MECHANICAL ENGINEERING

First Term	FIRST YEAR	Hrs. per wk. Rec.	Lab.	Cr. Hrs.
Math. 30	Advanced Algebra	6		6
Chem. 1	General Chemistry	3	4	5
Eng. 20	English and Pub. Speaking	3		3
Draw. 10	Engineering Drawing		6	3
G. E. 70	Elementary Engineering		2	1
C. 90	Co-ordination		2	1
Second Term				
Math. 31	Trigonometry	6		6
Chem. 2	General Chemistry	3	4	5
Eng. 21	English and Pub. Speaking	3		3
Draw. 11	Engineering Drawing		4	2
C. E. 210	Elementary Surveying		4	2
G. E. 71	Elementary Engineering		2	1
C. 91	Co-ordination		2	1

(Mechanical Engineering)

Summer Term		Hrs. per wk. Rec.	Lab.	Cr. Hrs.
Chem. 3	Qualitative Analysis		12	3
Draw. 12	Engineering Drawing		10	2
C. E. 211	Elementary Surveying		12	3

SECOND YEAR

First Term				
Math. 32	Analytical Geometry	6		6
Phys. 50	Mech., Molec. Phys. and Heat	4		4
Phys. 51	Physical Measurements		4	2
Draw. 13	Descriptive Geometry	2	6	5
Ch. E. 120	Metal. of Iron and Steel	2		1
C. 92	Co-ordination and English		2	1
Second Term				
Math. 33	Differential Calculus	5		5
Phys. 52	Elec., Sound and Light	4		4
Phys. 53	Physical Measurements		4	2
M. E. 420	Heat Engines	6		6
M. E. 421	Mechanical Engr. Lab		4	2
Ch. E. 121	Metal. of Iron and Steel	2		2
C. 93	Co-ordination and English		2	1
Summer Term				
Mech. 40	Statics	6		3
Phys. 54	Elec., Sound and Heat	5		2
Phys. 55	Physical Measurements		4	1
Ch. E. 122	Fuel and Gas Analysis		8	2

THIRD YEAR

First Term				
Math. 34	Integral Calculus	5		5
Mech. 41	Stat. and Mech. of Materials	6		6
M. E. 432	Mechanical Engr. Lab		4	2
M. E. 430	Thermodynamics	5		5
M. E. 431	Mech. Engr. Problems		4	2
C. 94	Co-ordination and English		2	1
Second Term				
Mech. 42	Mech. of Mater. and Dynamics	6		6
M. E. 435	Mechanism	2	6	5
E. E. 370	Elements of Elec. Engr.	4		4
E. E. 371	Electrical Engr. Lab		4	2
M. E. 433	Mechanical Engr. Lab		4	2
C. 95	Co-ordination and English		2	1

(Mechanical Engineering)

		Hrs. per wk. Rec.	Lab.	Cr. Hrs.
Summer Term				
Mech. 43	Dynamics	6		3
Ch. E. 132	Iron and Steel Analysis		12	3
E. E. 336	Elec. Motor Applications	5		2
First Term	FOURTH YEAR			
G. E. 72	Economics	3		3
G. E. 76	Principles of Accounting	2		2
Mech. 44	Hydraulics	4		4
M. E. 440	Elements of Mach. Design		8	4
E. E. 373	Elements of Elec. Engr	4		4
E. E. 374	Electrical Engr. Lab		4	2
C. 96	Co-ordination and English		2	1
Second Term				
G. E. 73	Economics	3		3
G. E. 77	Principles of Accounting	2		2
Mech. 46	Engineering Materials	3		3
Mech. 47	Materials Testing Lab		4	2
Ch. E. 142	Metallography	2	4	4
M. E. 441	Machine Design	1	4	3
C. 97	Co-ordination and English		2	1
	*Electives			2
Summer Term				
C. E. 243	Structural Design		16	4
Ch. E. 151	Heat Treatment of Steel		16	4
First Term	FIFTH YEAR			
M. E. 450	Industrial Management	3		3
M. E. 452	Production Engineering	3		3
M. E. 454	Heating and Ventilating	2	4	4
G. E. 78	Commercial Law	2		2
G. E. 80	Credits and Collections	3		3
G. E. 81	Business Correspondence	2		2
C. 98	Co-ordination and English		2	1
	*Electives			3
Second Term				
M. E. 451	Industrial Management	3		3
M. E. 453	Production Engineering	3		3
G. E. 79	Commercial Law	2		2
G. E. 82	Corporation Finance	4		4
G. E. 83	American Government	3		3
C. 99	Co-ordination and English		2	1
	*Electives			4

* Choice of electives is subject to the approval of the Head of this Department.

GENERAL COURSES

Chem. 1.—General Chemistry. Two lectures, one recitation, and two two-hour laboratory periods. A study of the fundamental laws and theories; the non-metallic elements and their important compounds.

Chem. 2.—General Chemistry. Two lectures, one recitation, and two two-hour laboratory periods. Review of chemical theories and continuation of the study of chemical elements and their compounds, supplemented by chemical problems. Prerequisite Chem. 1.

Chem. 3.—Qualitative Analysis. Twelve laboratory hours in the summer term. The chemistry of the metallic elements and their compounds; the application of chemical theory to the formation of insoluble compounds; the separation of bases and acids; the solution and analysis of salts and alloys. Prerequisite Chem. 2.

Chem. 4.—Quantitative Analysis—Gravimetric. One four-hour laboratory and class room period. Through individual laboratory instructions stress is laid on care and accuracy. This course is devoted to the gravimetric method of determination. This includes the study of the types, use and care of balances, a selected number of gravimetric determinations of basic and acid constituents to illustrate the different conditions of precipitation, washing, drying, decomposition, and weighing of precipitates. Prerequisite Chem. 1, 2, 3.

Chem. 5.—Quantitative Analysis.—Volumetric. One four-hour laboratory and class room period. The use and calibration of volumetric apparatus. Selection and use of indicators; preparation and standardization of volumetric solutions. A selected number of acidimetric, oxidimetric, and precipitation determinations. Prerequisite Chem. 4.

Chem. 6.—Organic Chemistry. Two lectures, one recitation, and one four-hour laboratory period. The general principles and theories of organic chemistry; physical and chemical properties of the compounds of the open chain series. Prerequisites Chem. 1, 2, 3.

Chem. 7.—Organic Chemistry. Two lectures, one recitation, and one four-hour laboratory period. Continuation of Course 6. Physical and chemical properties of the compounds of the closed chain series. Prerequisite Chem. 6.

Chem. 8.—Physical Chemistry. Two lectures and one four-hour laboratory period. The physico-chemical relations. The general principles of chemistry are studied and closely correlated with the laboratory work. The practical applications of the subject are emphasized. Prerequisite, Chem. 5, 7.

DRAWING

Drawing 10.—Elementary Drawing. Six hours drawing room work per week. The course consists of practice in the use of drawing instruments, practice in free hand lettering and elementary orthographic projection.

Drawing 11.—Elementary Drawing. Four hours drawing room work per week. Continuation of Draw. 10. Prerequisite, Draw. 10.

Drawing 12.—Advanced Drawing. Ten hours drawing room work during the summer term. Working drawings and tracings made from actual objects. Prerequisite, Draw. 11.

Drawing 13.—Descriptive Geometry. One lecture, one recitation and six drawing room hours per week. This is a study of orthographic projections as applied to the solution of problems involving the point, line and plane; representation of curved and warped surfaces, their intersections and developments. Problems are assigned for home work. Prerequisite, Draw. 12.

ENGLISH

English 20.—English and Public Speaking. Three class hours per week. A study of the forms of expression, chief stress being laid on exposition, both oral and written.

English 21.—English and Public Speaking. Three class hours per week. Continuation of English 20. Prerequisite English 20.

MATHEMATICS.

Math. 30.—Advanced Algebra. Six class hours per week. A brief review of negative and irrational numbers, indices, fractions, graphic and analytical discussion of linear and quadratic equations. Followed by a study of determinants, logarithms, complex numbers, solution of higher equations, introduction to series, convergence tests, undetermined co-efficients.

Math. 31.—Trigonometry. Six class hours per week. Elementary functions, their relations and graphs; functions of sums, differences and multiples of angles; solutions of plane and spherical triangles; solution of pure and mixed trigonometrical equations by graphic methods. Prerequisite, Math. 30.

Math. 32.—Analytical Geometry. Six class hours per week. A study of the properties of lines and the conic sections by means of the algebraic equations representing them. This study is extended to higher algebraic and transcendental curves wherever possible. Prerequisite, Math. 31.

Math. 33.—Differential Calculus. Five class hours per week. A study of the fundamental formulas and processes of differentiation.

followed by applications to maxima and minima, inflections, evolutes and motion of bodies. Prerequisite, Math. 32.

Math. 34.—Integral Calculus. Five class hours per week. A study of the fundamental formulas and processes of integration, followed by applications to curves, surfaces, volumes and also to Mechanics. Prerequisite, Math. 33.

Math. 35.—Differential Equations. Two class hours per week. The main purpose of this course is a study of the types of equations met in the various branches and the methods for their solution; the series methods naturally lead to a full study of the hyperbolic functions. Emphasis is laid upon the practical handling of equations encountered in Physics and Mechanics. Prerequisite, Math. 34.

Math. S-36. Mathematical Laboratory. Five class hours per week. A special course in which all students, deficient in mathematics will rectify this deficiency under the individual guidance of a member of the faculty. A passing grade of 70 per cent is demanded of each student, not only for the entire subject matter of each course but also in each chief topic of that course. Whenever a student, through sickness or any other cause, has missed out in an important part or chapter of his course, he will be obliged to report regularly at the Laboratory class until this deficiency has been made up. A student who has the first and second years Mathematics, but later manifests a weakness in one of these branches, will also be subject to attendance in this class until his weakness has been remedied.

MECHANICS

Mech. 40.—Statics of Mechanics. Six class hours per week during the summer term. Resolution and composition of forces, couples, conditions of equilibrium, center of gravity, moment of inertia, friction, etc. Prerequisite, Math. 33.

Mech. 41.—Statics and Mechanics of Materials. Six class hours per week. The first two weeks is a continuation of Mech. 40. The Mechanics of Materials treats of the application of the laws of Statics to various engineering materials. Elastic and ultimate strengths and deformations, cases of simple stress, simple and cantilever beams are covered. Prerequisite, Mech. 40.

Mech. 42.—Mechanics of Materials and Dynamics. Six class hours per week. The first six weeks is devoted to a study of the Mechanics of Materials, covering overhanging and fixed beams, continuous beams, columns and struts, torsion of shafts, apparent combined stresses, and compound columns and beams. The last three weeks is devoted to a study of Dynamics of Mechanics which includes a study of the laws of moving bodies, translation, rotation, friction, belts, work and energy. Prerequisite, Mech. 41.

Mech. 43.—Dynamics of Mechanics. Six class hours per week during the summer term. This is a continuation of Mech. 42. Prerequisite, Mech. 42.

Mech. 44.—Hydraulics. Four class hours per week. A study of the Mechanics of fluids, especial emphasis being given to liquids. Hydrostatics, including pressure of liquids in tanks and reservoirs, immersion and flotation, and hydrokinetics, including steady flow of water through pipes, orifices and open channels are taken up in detail. Prerequisite, Mech. 43.

Mech. 46.—Engineering Materials. Three class hours per week. A study of the properties and characteristics of materials used in engineering construction and methods of manufacture of same.

Mech. 47.—Materials Testing Laboratory. Four laboratory hours per week. Class tests to show methods of testing and to study the strength and general characteristics of various materials used in engineering construction. Prerequisite, Mech. 46.

Mech. 48.—Materials Testing Laboratory. Four laboratory hours per week. A continuation of Mech. 47 in which student performs individual tests of the various engineering materials. Prerequisite, Mech. 47.

PHYSICS.

Physics 50.—Mechanics, Molecular Physics and Heat. Four class hours per week. A careful analysis and study of the principles and laws of physics, their development, correlation and practical application. Special emphasis is given to Mechanics. Prerequisite, Math. 31.

Physics 51.—Physical Measurements. Four laboratory hours per week. Quantitative determination of physical constants; adjustments and use of instruments of precision such as micrometer, microscope, cathotometer, chronograph, etc. Verification of the laws of impact, torsion, rigidity, composition of harmonic motions, gravity. Young's Modulus, Moment of Inertia, etc. Determination of specific heats, coefficients of expansion, laws of gases, hygrometry. Prerequisite, Phys. 50.

Physics 52.—Electricity, Sound and Light. Four class hours per week. Analysis and study of the principles and laws of electricity, sound and light, and discussion of the theories which underlie the phenomena of these subjects. Emphasis is placed on the important application of the mechanics of waves and harmonic motion to these phenomena. Prerequisite, Phys. 50.

Physics 53.—Physical Measurements. Four laboratory hours per week. Experiments covering the laws of refraction, accurate measurements of indices of refraction, critical angle, magnifying power, photometry and spectrum analysis, interferometer. Electro-static

induction; theory of condenser; measurement of resistance; efficiency of electric motor; operation of alternator and transformer pyrometry. Prerequisite, Phys. 52.

Physics 54.—Electricity, Sound and Light. Five class hours per week during the summer term. Continuation of Phys. 52. Prerequisite, Phys. 52.

Physics 55.—Physical Measurements. Four laboratory hours per week during the summer term. Continuation of Phys. 53. Prerequisite, Phys. 53.

ELECTIVES.

Physics, S56.—Elementary Physics. Three class and two laboratory hours per week. An elementary and descriptive course to give a general idea of the principle phenomena and laws of physics. This course is given only for those students lacking the required high school credits in Physics.

Physics 57.—Advanced Physics. Mechanics and Heat. Three class hours per week. The mathematical theories of mechanics and heat as well as the refined methods of modern research are taken up; due attention is given to practical application in engineering and the industries in general. Prerequisites, Phys. 54, Math. 34.

Physics 58.—Measurements in Sound, Heat, Light. Four laboratory hours per week. Accurate measurements are made in such phenomena as stationary waves, Lissajous' curves, vapor tension, calorimetry, spectrometer, diffraction, grating, polariscope, bi-prism, photometer and interferometer. Prerequisite, Phys. 56.

Physics, 59.—Electricity, Light and Sound. Three class hours per week. Modern theories and methods are discussed with especial emphasis on the mathematical side. Prerequisite, Phys. 56.

Physics, 60.—Electrical Measurements. Four laboratory hours per week. The development of electrical theories. Calibration of measuring instruments; resistance of conductors, electrolytes, dialectrics, magnetic properties of iron, magnetometer, self-induction, inductance and capacity, high and low potentials, conduction of electricity through gases. Prerequisite, Phys. 58.

GENERAL ENGINEERING

G. E. 70.—Elementary Engineering. Two hours per week. A series of lectures designed to give Freshmen a general idea of the various fields of engineering.

G. E. 71.—Elementary Engineering. Two hours per week. A continuation of G. E. 70. Also includes inspection trips to various industrial establishments together with written reports.

G. E. 72.—Economics. Three class hours per week. A study of the general principles of economics especially as it relates to engineering problems and activities.

G. E. 73.—Economics. Three class hours per week. A continuation of course G. E. 72; includes money, credit and banking, international trade and protection, distribution of proceeds to rent, wages, interest and profits. Prerequisite, G. E. 72.

G. E. 75.—Contracts and Specifications. Three class hours per week. A study of the significance and requirements of engineering contracts and specifications.

G. E. 76.—Principles of Accounting. Two class hours per week. Elements of accounting, single and double entry; debits and credits; journalizing; posting and trial balance; closing books; proprietors' accounts; partnership accounts, etc.

G. E. 77.—Principles of Accounting. Two class hours per week. Advanced accounting; analytic study of the balance sheet; assets and liabilities; depreciation; capital stock; profits; surplus reserves; sinking funds; counting house methods, etc. Prerequisite, G. E. 76.

G. E. 78.—Commercial Law. Two class hours per week. Contracts; negotiable instruments; agency; partnership; corporations.

G. E. 79.—Commercial Law. Two class hours per week. Sales; bailments; carriers; guaranty and suretyship; insurance; real property and tenancy. Prerequisite, G. E. 78.

G. E. 80.—Credits and Collections. Three class hours per week. Forms of credit; classes of credit and credit machinery; duties and qualifications of credit man; elements of credit risk; sources of credit; information; financial statement; legal remedies of creditor; extensions, compositions and adjustments; bankruptcy; insolvency and receivership; credit safeguards.

G. E. 81.—Business Correspondence. Two class hours per week. The principles underlying every form of business English; general correspondence; sales letters; follow-up letters; circulars; reports.

G. E. 82.—Corporation Finance. Four class hours per week. A study of the organization and financial management of corporations including business promotion; principles of capitalization; means of financing an organization; determination of profits; valuation of securities; methods of consolidation; reorganization of corporations.

G. E. 83.—American Government. Three class hours per week. A study of the development and practical working of our federal, state and local governments.

ELECTIVES

G. E. 84.—Geology. Three class hours per week. A general study of the dynamic, structural, physiographic, historical and economic geology. Prerequisite, C. E. 249.

G. E. 85.—Advertising. Three class hours per week. Psychology of appeal; color; memory; inducing action; analysis of successful advertisements; the advertising agency, etc.

G. E. 86.—Practical Salesmanship and Sales Administration. Three class hours per week. Personal qualifications; tact; address and their development; a study of the elements that make for success; knowledge of the goods to be sold; studying the prospective buyer; approach, demonstration, presentation of argument; closing the sale.

G. E. 87.—Astronomy. Three class hours per week. A descriptive course acquainting the student with the fundamental principles and facts regarding the sun, moon, planets, comets, the stellar system, including the principle constellations, nebulae, etc. Prerequisite, Math. 34.

G. E. 88.—Astronomy. Three class hours per week. Theory and use of the sextant, theodolite, transit and equatorial telescope. Determination of time, latitude, longitude and azimuth with portable instruments. Prerequisite, G. E. 87.

CO-ORDINATION

C. 90 to C. 99 inclusive. Two hours per week each. This includes a report on the outside co-operative work after each work period and participation in the regular meetings of the Engineering Association.

The latter organization has both a cultural and social end in view. It professes to train the young engineer under competent direction to fluency, ease and proficiency in public speaking. At the same time it affords an outlet for the social activities of its members.

CHEMICAL ENGINEERING COURSES

Ch. E. 120.—Metallurgy of Iron and Steel. Two class hours per week. A study of the sources of raw material, methods of obtaining the ore and the various processes of producing steel; rolling mill and foundry practice.

Ch. E. 121.—Metallurgy of Iron and Steel. Two class hours per week. A continuation of Ch. E. 100, including the properties of special steels and their application to industry.

Ch. E. 122.—Fuel and Gas Analysis. Eight laboratory hours per week. Analysis of coal and coke, including a calorimetric determination by means of Hempel apparatus. The application of the Orsat apparatus to the analysis of flue gases. Prerequisites, Chem. 1 and 2.

Ch. E. 130.—Inorganic Technical Analysis. Four laboratory hours per week. The technical methods of quantitative analysis of limestone and cement. Prerequisite, Chem. 5.

Ch. E. 131.—Inorganic Technical Analysis. Eight hours laboratory work per week in the summer term. A continuation of Ch. E. 130, including methods for the quantitative analysis of alloys.

Ch. E. 132.—Iron and Steel Analysis. Twelve laboratory hours per week in the summer term. Technical methods for determining the important constituents in cast iron, carbon and alloy steels. Prerequisites, Chem. 3 and Ch. E. 122.

Ch. E. 140.—Applied Electro Chemistry. Two lectures and one four-hour laboratory period. The application of the principles of electro-chemical and electro-thermal reactions to the decomposition of compounds, electro-plating, and electro-quantitative chemical analysis. Prerequisites, Chem. 5 and E. E. 370.

Ch. E. 141.—Applied Thermal Chemistry. Three class hours per week. This course includes the investigation of chemical reactions which take place at high temperatures with particular reference to metallurgical calculations. Prerequisites, Ch. E. 121.

Ch. E. 142.—Metallography. Two lectures and one four-hour laboratory period per week. The diagram of thermal equilibrium, solid solutions, and the application of the phase rule to metallography. The laboratory work consists of calibration and practise in the use of metallographic equipment including the preparation and study of micro sections. Prerequisites, Ch. E. 121, Ch. E. 132.

Ch. E. 143.—Organic Technical Analysis. Sixteen hours laboratory work per week in the summer term. The technical methods of analysis of organic industrial materials; their identification and application to industry. Prerequisite, Chem. 7.

Ch. E. 150.—Organic Technical Analysis. Eight hours laboratory per week. This is a continuation of Ch. E. 143.

Ch. E. 151.—Heat Treatment of Steel. Eight hours per week in laboratory. A laboratory study of modern methods in heat treatment of steel. Purposes of heat treating; methods of temperature control, design of furnaces, annealing, hardening, tempering and case hardening. Prerequisite, Ch. E. 121.

Ch. E. 152.—Industrial Chemistry. Five hours per week. Lectures, written reports and inspection trips. A study of industrial processes of chemical manufacture.

ELECTIVES.

Ch. E. 160.—Technical Pyrometry. Four hours per week. Laboratory study of high temperature measurements, calibration of thermo-couples, resistance pyrometers and the use of these instruments in industry.

Ch. E. 161.—Water Analysis. (Industrial.) Fitness for boiler and other industrial uses. The softening of water.

Ch. E. 162.—Water Analysis. (Sanitary.) The analysis of potable waters. This course also includes the bacterial count and determination of the presence or absence of the bacteria of the colon group.

CIVIL ENGINEERING COURSES

C. E. 210.—Elementary Plane Surveying. One class hour and three hours of office and field work per week. Principles and usage of the tape in measuring distance, of the level in measuring differences in elevation and of the transit in measuring horizontal and vertical angles. Work covers problems in measurement of distance, differential leveling, road and building cross-sections, profiles, etc.

C. E. 211.—Elementary Plane Surveying. Twelve hours field work per week during summer term. Continuation of the field work of C. E. 210. Prerequisite, C. E. 210.

C. E. 220.—Plane and Topographic Surveying. Three class hours and four office and field hours per week. Principles and usage of the Engineers' Transit. Adjustments of Transit, Dumpy and Wye levels. A detailed study of the various problems in which the transit is used, such as traverses; city, land, topographic, mining and governmental surveys; miscellaneous surveying problems. Prerequisite, C. E. 211.

C. E. 221.—Plane and Topographic Surveying. Eight field hours per week during the summer term. Continuation of the field work of C. E. 220. Prerequisite, C. E. 220.

C. E. 230.—Advanced Surveying. Three class hours and six office and field hours per week. A study of solar and stellar observations for determination of meridian, time, latitude and longitude, higher triangulation systems, plane table surveys, hydrographic surveys and the principles of precise and barometric leveling. Note reducing and map-making is taken up in the office work. Prerequisite, C. E. 221.

C. E. 231.—Railroad Curves. Three class hours per week. A study of simple, compound, reverse and transition curves, turn-outs, cross-overs, frogs and switches. Prerequisite, C. E. 221 and C. E. 230.

C. E. 232.—Railroad Location. Eight hours field work per week during the summer term. Projection of line, running in simple and transition curves, turn-outs and cross-overs. Prerequisite, C. E. 231.

C. E. 233.—Railroad Location. Sixteen hours field and office work per week during summer term. Field and office practice of railroad location. Reconnaisance, preliminary, final location and cross-sections of line comprise the field work. The office work covers the paper location of final line, calculation of quantities, plotting of profile, mass diagram and calculation of dirt distribution. Prerequisite, C. E. 232.

C. E. 235.—Theory of Structures. Five class hours per week for five weeks and three class hours per week for four weeks. A study of the principles involved in the determination by both graphical and analytical methods of the stresses in various types of roof and bridge trusses. Prerequisite, Mech. 41.

C. E. 236.—Theory of Structures. Five class hours per week during summer term. Continuation of C. E. 235. Prerequisite, C. E. 235.

C. E. 240.—Structural Design. Eight hours drawing room work per week. Complete design of wooden roof truss. Prerequisite, C. E. 236.

C. E. 241.—Structural Design. Eight hours drawing room work per week. Complete design of steel roof truss. Prerequisite, C. E. 236.

C. E. 242.—Structural Design. Twelve hours drawing room work per week during the summer term. Complete design of railroad deck plate girder bridge. Prerequisite, C. E. 236.

C. E. 243.—Structural Design. Sixteen hours drawing room work per week during the summer term. Complete design of a steel roof truss. Given to Chemical, Electrical and Mechanical Engineering students. Prerequisite, Mech. 41.

C. E. 244.—Principles of Reinforced Concrete. Three class hours per week. A study of the principles of reinforced concrete and its application to building design. Prerequisite, C. E. 235.

C. E. 245.—Principles of Reinforced Concrete. Two class hours per week. Continuation of C. E. 244. Prerequisite, C. E. 244.

C. E. 246.—Principles of Reinforced Concrete. Five class hours per week during the summer term. A study of the principles of reinforced concrete and its application to various types of construction. Prerequisite, C. E. 245.

C. E. 247.—Reinforced Concrete Design. Twelve drawing room hours per week during the summer term. Design of a reinforced concrete building. Prerequisite, C. E. 245.

C. E. 248.—Railroad Construction and Maintenance. Three class hours per week. A study of the methods and materials of construction and maintenance, structures and appliances. Prerequisite, C. E. 233.

C. E. 249—Hydrology. Three class hours per week. A study of precipitation, run-off, stream flow, evaporation, seepage, etc., as effected by topographical and geological conditions. Prerequisite, Mech. 44.

C. E. 250.—Public Water Supply. Three class hours per week. A study of the principle features of water-works design and construction, including quantity and quality of potable water, sources of supply, design of distribution systems, reservoirs, dams and tanks. Prerequisite, Mech. 44.

C. E. 251.—Sewerage. Three class hours per week. A study of the design and construction of sewerage systems including surveys and estimates, determination of size and capacity of sewers and the various methods of sewage disposal. Prerequisite, Mech. 44.

C. E. 253.—Highways. Three class hours per week. Design, construction and maintenance of highways and streets. Study of various types of pavements. Prerequisite, C. E. 230.

C. E. 254.—Foundations. Three class hours per week. A study of the theory and design of various types of foundations. Prerequisite, Mech. 42.

C. E. 255.—Reinforced Concrete Design. Four hours office work per week. Problems of design of various types of reinforced concrete structures. Prerequisite, C. E. 246.

C. E. 256.—Concrete Arch Design. Six hours office work per week. Complete design of a reinforced concrete arch. Prerequisite, C. E. 246.

C. E. 257.—Bridge Design. Twelve hours office work per week. Design of a pin-connected railroad bridge. Prerequisite, C. E. 242.

ELECTIVES

C. E. 260.—Irrigation and Drainage. Two class hours per week. A study of the methods and means of irrigation, design and construction of reservoirs, canals, flumes and other irrigation works. Also a study of the principles involved in reclamation of land by drainage. Prerequisite, Mech. 44.

C. E. 261.—City Planning. Two class hours per week. A study of the principles involved in the laying out of street systems, park systems, etc., and problems of future municipal expansion. Prerequisite, C. E. 230.

C. E. 262.—Railroad Terminals. Three class hours per week. A study of railroad terminals, including yard layouts together with structures and appliances in connection therewith. Prerequisite, C. E. 248.

C. E. 263.—Advanced Theory of Structures. Three class hours per week. A graphical and analytical study of the stresses in statically indeterminate structures, redundant members and deflections. Prerequisite, C. E. 236.

C. E. 264.—Advanced Bridge Design. Six hours office work per week. Design of movable bridges. Prerequisite, C. E. 257.

C. E. 265.—Water Power Engineering. Three class hours per week. A study of the principles involved in the consideration of a water power project, such as effects of variation of flow, head, etc., types, characteristics, selection and installation of water wheels. Prerequisite, Mech. 44.

ELECTRICAL ENGINEERING COURSES

E. E. 330.—Elements of Electrical Engineering. Four class hours per week. An introductory study of electrical machinery and its chief applications. Prerequisites, Physics 50-53 and Math. 33.

E. E. 331.—Electrical Engineering Laboratory. One four-hour laboratory period per week with reports. A course of some of the simpler experiments in Direct Current testing, designed to familiarize the student with connecting and operating generators and motors, and obtaining their performance characteristics.

E. E. 333.—Elements of Electrical Engineering. Four class hours per week. This is a continuation of E. E. 330. A brief treatment of Alternating Current machines is included. Prerequisite, E. E. 330.

E. E. 334.—Electrical Engineering Laboratory. Four laboratory hours per week. This is a continuation of E. E. 331. Some of the simpler tests of A. C. apparatus and motors will be made. Prerequisite, E. E. 331.

E. E. 336.—Electric Motor Applications. Five class hours per week in the summer term. This course is a detailed study of the methods of control which are essential in adapting electric motors to the conditions met with in various industries. Prerequisite, E. E. 330.

The above courses are open to Mechanical or Civil Engineering students; who, through irregular schedule, cannot take E. E. 370—E. E. 374.

E. E. 338.—Elementary Electrical Problems. Two three-hour periods spent in the computing room during the summer term. This course has for its object the acquirement of facility and skill in making electrical computations. This course begins two years' work in Electrical Computations and Design, in which various projects are considered, beginning from simple layouts of wiring and advancing to such projects as the design of a machine, or the study of an electric railway project. Prerequisite, E. E. 330.

E. E. 339.—Electrical Machinery and Apparatus. Three class hours per week in the summer term. This course begins a detailed quantitative study of the various types of machinery, which extends for one year. In the summer term the Electric and Magnetic Circuits will be considered. The subjects of Generators, Motors, Transformers, Converters are then considered in order, from both the designer's and operator's point of view. Prerequisites, E. E. 330 and E. E. 331.

E. E. 340.—Electrical Machinery and Apparatus. Four class hours per week. This course is a continuation of E. E. 339. Prerequisites, E. E. 330 and E. E. 331.

E. E. 341.—Electrical Engineering Laboratory. One four-hour laboratory period per week with reports. E. E. 340 must accompany this course. Among the experiments performed in this course are such advanced tests as the analysis of dynamo performance, efficiency from losses, and compromise testing. Prerequisites, E. E. 330 and E. E. 334.

E. E. 342.—Electrical Problems. One two-hour period per week in the computing room. Continuation of E. E. 338. In the Junior year it is the intention of this course to give power to apply electrical principles to concrete projects of a simple character. Occasional inspection trips to important electrical installations in Milwaukee will be made. Layout of shop wiring, motor selection, lighting installation, and working up of test data will be carried out. Prerequisites, E. E. 330, and E. E. 333, or E. E. 339.

E. E. 343.—Illumination. Three class hours per week. This is the beginning of a two-term course on the production, modification, utilization and measurement of light. The end in view is to enable the student to understand the factors governing the choice of the kind, size, and number of lamps, their location and accessories. Prerequisites, E. E. 330 and E. E. 333 or E. E. 339.

E. E. 344.—Illumination. Three class hours per week. Continuation of E. E. 343. Prerequisite, E. E. 343.

E. E. 345.—Electrical Machinery and Apparatus. Four class hours per week. Continuation of E. E. 339 and E. E. 340. Prerequisites, E. E. 340 and E. E. 339 or E. E. 333.

E. E. 346.—Electrical Engineering Laboratory. One four-hour laboratory period per week with reports. Continuation of E. E. 341. Prerequisites, E. E. 330-334.

E. E. 347.—Electrical Problems. One two-hour period per week in the computing room. Continuation of E. E. 338 and E. E. 342. Prerequisites, E. E. 330-334.

E. E. 348.—Electrical Problems. Two three-hour periods per week in the computing room in the summer term. Continuation of E. E. 338, 342 and 347. Prerequisites, E. E. 330-334.

E. E. 349.—Electric Power Distribution. Five class hours per week in the Summer term. A course beginning a year's study of the general subject of Electric Power. First, the methods of providing electric service are considered, followed by a study of power plants, and sub-stations. The subject of power costs and rates are then studied, and in the spring term the features of high voltage, long distance transmission will be considered. Prerequisites, E. E. 330-334.

E. E. 350.—Electric Power Stations. Five class hours per week. A continuation of E. E. 349. Prerequisites, E. E. 330-334.

E. E. 351.—Telephone Engineering. Five class hours per week. A systematic study of the science and art of communication with particular attention to the topics of standard telephone practice, telephonic transmission and interference, machine switching, and the applications of the vacuum tube. Prerequisites, E. E. 330-334 and E. E. 339.

E. E. 352.—Theory of Electrical Design. Three class hours per week. A discussion of how the performance characteristics, heating, and efficiency of a machine depend on its size and proportions. A detailed study of how these factors determine a design is then made. Prerequisites, E. E. 339 and E. E. 340.

E. E. 353.—Electrical Design. Four hour period in the drawing room per week. Must be taken with E. E. 352. While the design of an electric machine will be made in this course, more general projects, such as the selection of equipment for a transmission line, small generating plant, and the computation of a railroad schedule will also be undertaken. Occasional inspection trips will be made. Continued in the second term as E. E. 354. Prerequisites, E. E. 339 and E. E. 340.

E. E. 354.—Electrical Design. Four hour period in the drawing room per week. Continuation of E. E. 353. Prerequisites, E. E. 339 and E. E. 340.

E. E. 355.—Electric Railway Engineering. Five class hours per week in the second term. This course is a study of the present practice of Electric Railways. Topics such as track construction and brake equipment of chief interest to Civil and Mechanical Engineers are treated as well as purely electrical features such as control and motors. The most attention will be devoted to the topics of power consumption and schedule. Prerequisites, E. E. 330 and E. E. 334.

ELECTIVES

E. E. 360.—Electric Power Transmission. Three class hours per week in the second term. Continuation of E. E. 349 and E. E. 350. Topics such as Corona, Insulation, and Arresters, determined by the

high voltage; and resonance and surges, present in very long lines, will be considered. Operating characteristics will also be studied. Prerequisite, E. E. 350.

E. E. 361.—Wiring for Light and Power. Three class hours per week in the second term. Open to all students. A study of the principles underlying the National Fire and Safety codes, and of customary practice in installing wiring. Prerequisites, E. E. 330 and E. E. 333, or E. E. 370 and E. E. 373.

E. E. 362.—Factory Lighting. Three class hours per week in the second term. Open to all students. A brief study of Illumination in its relation to correct forms of shop installations. Prerequisites, E. E. 330 and E. E. 333, or E. E. 370 and E. E. 373.

E. E. 363.—Advanced Laboratory. One four-hour period per week in either term with only general supervision on an individually assigned problem. Intensive independent work is expected. Prerequisite, E. E. 346.

E. E. 364.—Advanced Design. One four-hour period per week in the second term. An individually assigned project, either chosen by student or assigned by instructor, such as the selection of railway motor equipment or the design of an A. C. machine. Prerequisites, E. E. 353 and E. E. 354.

E. E. 365.—Report of Current Electrical Literature. One four-hour period per week in library, in either term. A search through the files of periodicals for articles on assigned topic, and a digest or resumé of results and conclusions found by authors. Prerequisites, E. E. 330 and E. E. 334.

Courses in Hydraulic and Steam Power plants offered by C. E. and M. E. departments are acceptable electives. Students desiring such should consult departments involved.

ELECTIVES FOR C. E. AND M. E. STUDENTS

In addition to electives mentioned above, E. E. 350 and E. E. 355 are open to M. E. and C. E. students.

ELECTRICAL COURSES FOR NON-ELECTRICAL STUDENTS.

E. E. 370.—Elements of Electrical Engineering. Four class hours per week in the second term. A brief study of electrical machinery with emphasis upon its applications. Motors are given considerable attention, inasmuch as the field of usefulness of each type is fully discussed. A short treatment of Alternating Current machinery is also given, in the continuation of this course given in the first term. Prerequisites, Phys. 50-53 and Math. 33.

E. E. 371.—Electrical Engineering Laboratory. Four hours laboratory per week in the second term. A course of some of the simpler experiments in the testing of motors, generators, and other electrical machines. This course has for its object the acquainting of the student with the measurement of efficiency, and the relative behavior of different types of motors. Must be accompanied or preceded by E. E. 370. Prerequisites, Phys. 50-53 and Math. 33.

E. E. 373.—Elements of Electrical Engineering. Four class hours per week in the first term. Continuation of E. E. 370. Prerequisite, E. E. 370.

E. E. 374.—Electrical Engineering Laboratory. Four hours laboratory per week with report. Continuation of E. E. 371. Must accompany E. E. 373 or follow it. Prerequisite, E. E. 370.

The above four courses are similar to E. E. 330-334.

MECHANICAL ENGINEERING COURSES

M. E. 420.—Heat Engines. Six class hours per week. This course embraces a study of various types of steam boilers and power plant equipment; simple and compound engines, steam turbines, air compressors and internal combustion engines. Prerequisites, Chemistry 2 and Phys. 50.

M. E. 421.—Mechanical Engineering Laboratory. Four hours per week. This is a laboratory course which runs parallel with M. E. 420 and includes the calibration of pressure gauges, thermometers, meters, calorimeter tests of steam, and practice in the use of the engine indicator. It is intended to familiarize the student with mechanical laboratory instruments.

M. E. 425.—Heat Engines. Three class hours per week. Similar to M. E. 420. Required for Ch. E. and C. E. students. Prerequisites are the same for M. E. 420.

M. E. 426.—Heat Engines. Two class hours per week. This is a continuation of M. E. 425, Summer term. Required for Ch. E. and C. E. students.

M. E. 430.—Thermodynamics. Five class hours per week. A detailed study of the gas laws, various heat cycles, entropy, temperature-entropy diagram, and the application of thermodynamics to the various types of heat engines. Prerequisites, Chem. 2, Physics 50 and Math. 33.

M. E. 431.—Mechanical Engineering Problems. Four class hours per week. This course is supplementary to M. E. 430 and consists of a series of selected problems, involving the application of thermodynamic principles, to be worked out in the drafting room.

M. E. 432.—Mechanical Engineering Laboratory. Four hours laboratory per week. A continuation of M. E. 421, which includes tests of boiler flue gases, flow of steam through orifices, steam engine valve setting, mechanical efficiency tests of steam and gas engines, and a complete test of a power plant. Prerequisites, M. E. 420 and M. E. 421.

M. E. 433.—Mechanical Engineering Laboratory. Four hours laboratory per week. Tests to determine the operating characteristics and thermal efficiencies of steam and gas engines, air compressors, pumps, etc. Prerequisites, M. E. 430 and M. E. 432.

M. E. 434.—Mechanical Engineering Laboratory. Four hours laboratory per week. A special course for Civil Engineers which includes calibration of instruments, and tests of steam and gas engines. Prerequisites, M. E. 425 and M. E. 426.

M. E. 435.—Mechanism. Two class hours per week and six hours per week in the drafting room. A systematic study of velocity diagrams as applied to the motion of machine parts. Considerable time is devoted to the design of cams and gears. Prerequisites, Draw. 13 and Phys. 50.

M. E. 440.—Elements of Machine Design. Eight hours per week in the drafting room. This is a continuation of M. E. 435 with the application of mechanics necessary to determine the strength of machine parts. Each student is required to complete the design of some simple machine. Prerequisites, M. E. 435 and Mech. 42.

M. E. 441.—Machine Design. One lecture and one four-hour drafting period per week. The application of dynamics to the design of machine parts with special reference to inertia forces in reciprocating machines, and methods employed in balancing these forces. Prerequisites, M. E. 440 and Mech. 43.

M. E. 450.—Industrial Management. Three class hours per week. Offered only to students with at least two years of practical experience in industry. The course deals with the various methods of modern industrial organization, the principles of cost keeping, depreciation of equipment, purchasing and storing of materials, and sales organization. Prerequisites, G. E. 72 and G. E. 76.

M. E. 451.—Industrial Management. Three class hours per week. A continuation of M. E. 450, which includes the discussion of labor problems, welfare work, safety and sanitation. Prerequisite, M. E. 450.

M. E. 452.—Production Engineering. Three class hours per week. This course is open only to students who have had at least two years of practical shop experience. It includes a study of shop management problems, such as: routing of products, time study and bonus systems, stock records, inspection systems, safety devices and the human element in production.

M. E. 453.—Production Engineering. Three class hours per week. A continuation of course M. E. 452, which consists of numerous inspection trips and written reports on shop processes and equipment.

M. E. 454.—Heating and Ventilating. Two class hours per week. Four hours per week in drafting room. Direct and indirect steam and hot water heating, gravity systems, vacuum systems, direct air heating, ventilating, temperature and humidity control, heating boilers and furnaces. The course includes a complete layout of a heating and ventilating system for a typical factory building.

ELECTIVES

M. E. 460.—Experimental Engineering. Four to eight hours per week. The assignment of an experimental investigation in the nature of research work. Investigations suggested by the student's contact with shop problems may be conducted here. Elective for fifth year M. E. students.

M. E. 461.—Advanced Machine Design. Four to six hours per week. Individual design problems for students who have decided to become designers after two years of practical shop experience. The nature of the design will conform to the student's choice of industry. Electives for fifth year M. E. students.

M. E. 462.—Power Plants. Seven hours per week. Drafting room work supplemented by lectures. A discussion of the problems involved in the selection of power plant units together with the auxiliary equipment. Each student is required to select and arrange the equipment for a complete power plant. Prerequisite, M. E. 420.

M. E. 463.—Compressed Air. Four class hours per week. A mathematical treatment of problems entering into the production, transmission, and the application of compressed air. A study is made of the air compressor with particular reference to the effect of clearance, methods of cooling, advantages of compounding, etc. Attention is given to the hydraulic compressor, friction of air in pipes, and the air lift. Prerequisites, M. E. 420 and M. E. 430.

M. E. 464.—Refrigeration. Three class hours per week. This course is designed to give the student a working knowledge of the problems entering into the selection of a mechanical refrigeration plant, and includes a complete description of the various types of ice machines and systems of refrigeration. Prerequisites, M. E. 420 and M. E. 430.

M. E. 465.—Steam Turbines. Three hours per week. The application of thermodynamic principles to the design of steam turbines and a discussion of the various types, their adaptability for different classes of service, and a comparison with the reciprocating engine. Prerequisites, M. E. 420 and M. E. 430.

GENERAL COURSES

In addition to the subjects listed, there are various subjects offered in the other Colleges of the University which are open to the students in Engineering, at the discretion of the Heads of the Departments.

STUDENT ENROLLMENT OF THE COLLEGE OF APPLIED SCIENCE AND ENGINEERING

1920—1921

CALIFORNIA

Chie, Joseph ..... San Francisco
Ng, Bock J..... San Francisco

CUBA

Novoa, Jos. M..... Marianas

ENGLAND

Wareing, Herb. F..... London

GEORGIA

McLendon, Wm. C..... Macon

ILLINOIS

De Haye, J. F..... Wilmette
Fox, Jas. ..... Griggsville
Freiberg, A. J..... River Forest
Gaines, A. H..... Quincy
Gibbons, J. J..... Hanover
Hersam, H. M..... Dixon
Houy, D. H..... Galena
La Motte, E. C..... Ste. Marie
Pryor, Wm. E..... Chicago
Sloan, J. F..... Lockport
Timm, T. ..... Tuscola

INDIANA

Krawczyk, I. J..... Hammond
Studer, V. E..... Whiting

IOWA

Brazel, H. ..... Pocohontas
Brugger, K. A..... East Dubuque
Cordes, E. L..... Waterloo
Coughlin, W. E..... Melrose
Evans, E. ..... Des Moines
Goodman, A. J..... Rhodes
Gore, R. J..... Murray
Hamacher, K. F..... Waterloo

Hickey, L. ..... Pocohontas
Jacobsen, H. E. ..... St. Olaf
Keltz, M. E. ..... Superior
Linnan, F. M. ..... Pocohontas
McAllister, C. ..... De Witt
McEvoy, E. J. ..... Adair
McNamara, C. B. ..... Dubuque
Olsen, A. G. ..... St. Olaf
Page, K. J. ..... Dubuque
Reilly, F. P. ..... Emmetsburg
Truxaw, L. P. ..... Riverside

KANSAS

Holford, G. L. ..... Topeka
McGinnis, J. L. ..... Topeka
McKinley, T. T. ..... Scranton

MICHIGAN

Basso, A. L. ..... Ironwood
Bettiga, D. ..... Vulcan
Bohte, A. J. ..... Calumet
Calkins, E. R. ..... Wayland
Dundon, T. S. ..... Ishpeming
Forte, V. J. ..... Ironwood
Frank, J. ..... Laurium
Hare, J. J. ..... Ishpeming
Lyons, J. W. ..... Howell
McManman, F. R. ..... Ironwood
McMullin, F. C. ..... Ontanagon
Perrizo, P. A. ..... Daggett
Petranek, J. J. ..... Bessemer
Rosatti, D. C. ..... Vulcan
Suess, V. E. ..... Negauna

MINNESOTA

Des Rosiers, G. A. ..... Chisolm
Finn, S. B. ..... Rochester
Flock, B. J. ..... Mankato
Gulden, J. L. ..... Austin
Kersten, C. J. ..... Rochester
Lamping, J. G. ..... Austin
McLane, W. C. ..... Graceville
McNamara, J. M. ..... Hibbing
Ruder, F. ..... Redwood Falls

Seewald, F. V.....Rochester
Steffes, A. M.....Rollongham
Thill, M. W.....Austin
Triggs, E. O.....Winona
Veranth, J. .....Ely
Welch, G. F.....Wodena
Wegner, W. F.....Morristown
Zender, L. .....Austin

MISSOURI

Cahill, E. D.....St. Louis
O'Neill, T. S.....Marceline

MONTANA

McKeever, J. E.....Forsythe
Palen, J. W.....Caledonia

NEBRASKA

Coyle, V. B.....Norfolk

NORTH DAKOTA

Johnson, J. O.....Grafton
Larson, A. L.....Grand Forks
Nuss, P. A.....Grand Forks

OHIO

Forsthoefel, G. F.....Maria Stein

OKLAHOMA

Predergast, W. .....Fort Smith

PENNSYLVANIA

Soo, H. B.....Scranton

PHILIPPINE ISLANDS

Raroque, S. L.....Alaminos

SOUTH DAKOTA

Cosgrove, T. F.....Madison
Linster, E. F.....Sisseton
Moriarity, J. D.....Marion
Suhr, H. F.....Milbank

WISCONSIN

Alpine, R. L.....Wisconsin Rapids
Alstaetter, H. E.....Thiensville
Amalotti, E. J.....Milwaukee
Baker, R. J.....Milwaukee
Baranowski, S. W.....Oshkosh
Barber, J. W.....Milwaukee
Barrett, L. W.....Thorp
Baumbach, G. E.....Milwaukee
Bayerlein, R. W.....Milwaukee
Beck, S. E.....Waubena
Bentert, J. R.....Milwaukee
Benyas, D. .....Appleton
Berghammer, E. P. .....Milwaukee
Bergin, F. J.....Fond du Lac
Bergin, W. T.....Fond du Lac
Bernhard, E. F.....Milwaukee
Biagi, J. M.....Milwaukee
Bischoff, N. M.....Hales Corners
Bleck, H. B.....Milwaukee
Bogenberger, J. W.....Milwaukee
Bonn, M. F.....Lancaster
Bonness, J. D.....Milwaukee
Bouchard, R. J.....Suamico
Brah, S. M.....Milwaukee
Brey, E. E.....Park Falls
Budsien, A. .....Milwaukee
Buehner, H. A.....Milwaukee
Burbach, P. H.....Milwaukee
Callaway, H. D.....Milwaukee
Carey, P. E.....Milwaukee
Cheifetz, S. L.....Milwaukee
Conway, N. P.....Wisconsin Rapids
Cummisford, R. G.....Milwaukee
Danneker, M. A.....Milwaukee
Davis, M. G.....West Allis
Degentesch, H. E.....Milwaukee
De Guere, R. M.....Wisconsin Rapids
Eckelman, L. J.....Milwaukee
Ellwanger, M. H.....Wauwatosa
Elsen, F. C.....Merrill
Evenson, H. O.....Minocqua

Flaherty, M. E.....Mauston
Fleming, H. J.....Milwaukee
Fleming, L. F.....Salem
Fons, A. D.....Whitefish Bay
Frank, L. C.....Milwaukee
Frederick, A. E.....Fairchild
Frentzel, H. C.....Milwaukee
Freudenburg, K. W.....Wauwatosa
Freund, C. C.....Wisconsin Rapids
Gates, E. L.....Milwaukee
Gebhard, J. P.....Milwaukee
Gerrits, E. J.....Little Chute
Gieschen, A. F.....Wauwatosa
Gieschen, H. C.....Wauwatosa
Govin, J. W.....Menomonee
Grimes, J. W.....Neenah
Grogan, L. W.....Milwaukee
Grosjean, H. W.....Milwaukee
Hock, J. J.....Rhinelander
Haertel, C. F.....Milwaukee
Hartman, G. L.....Milwaukee
Hartman, M. C.....Milwaukee
Hayes, C. M.....Green Bay
Hebard, W. J.....Milwaukee
Heiman, E. F.....Wausau
Hill, A. S.....Milwaukee
Hintz, F. W.....Milwaukee
Hirth, R. B.....Milwaukee
Hofman, V. J.....Marion
Hoffman, N. N.....Milwaukee
Hornig, H. E.....Milwaukee
Huiras, F. A.....Fredonia
Hunt, G. B.....Milwaukee
Hurtgen, C. A.....Kenosha
Hyatt, H. H.....Sparta
Johnson, C. A.....Eau Claire
Jones, R. H.....Hudson
Kachel, D. T.....Whitewater
Kachel, L. W.....Whitewater
Kahn, W. P.....Dorchester
Kansier, V. H.....Reedsburg
Kauffung, C. H.....Milwaukee

Kelbe, R. ..... Milwaukee
Kelly, D. J. ..... Woodman
Kelly, J. G. ..... Milwaukee
Kenney, L. M. ..... Milwaukee
Kenning, R. ..... Janesville
Klein, C. ..... Milwaukee
Koch, A. J. ..... Port Washington
Konwinski, H. J. ..... Milwaukee
Kroha, L. J. ..... Milwaukee
Krohne, A. D. ..... West Allis
Kryszewski, L. A. ..... Milwaukee
Kurath, F. ..... Milwaukee
Kurtz, R. C. ..... Milwaukee
Kyes, L. H. ..... Milwaukee
Lamb, E. J. ..... Sheboygan
Lambeck, W. ..... Milwaukee
Larson, W. A. ..... Marinette
Lawinger, W. A. ..... Mineral Point
Le May, E. A. ..... Tomahawk
Machowski, M. D. ..... Beaver Dam
MacMillan, A. ..... St. Bay
Maguire, F. A. ..... Milwaukee
Mallow, A. H. ..... Watertown
Maloney, M. C. ..... Sheboygan
Marshall, C. L. ..... Milwaukee
Marx, L. G. ..... Kewaskum
McCabe, J. B. ..... Milwaukee
McCarville, W. A. ..... Mineral Point
McClurg, C. F. ..... Fox Lake
McLaughlin, E. J. ..... Milwaukee
Meleski, J. A. ..... Lena
Merten, L. ..... Milwaukee
Methinitis, S. A. ..... Milwaukee
Meyer, L. J. ..... Fredonia
Meyer, R. B. ..... Two Rivers
Miller, W. J. ..... Fox Lake
Miotke, H. A. ..... Milwaukee
Mirgeler, W. J. ..... Milwaukee
Murphy, J. P. ..... Benton
Murphy, J. B. ..... Milwaukee
Nash, R. A. ..... Neenah
Norton, H. M. ..... Milwaukee

Parks, B. W.....Park Falls
Patitz, W. E.....Stevens Point
Pawlicki, E. H.....Hurley
Pederson, H. E.....Oconto
Peeples, J. A.....Thorpe
Peters, F. G.....Milwaukee
Pierick, E. T.....Milwaukee
Pilon, L. A.....Fond du Lac
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Prellwitz, W. B.....Milwaukee
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Reitmeyer, W. B.....Milwaukee
Riffle, F. .....Milwaukee
Rohn, R. T.....Milwaukee
Rogatz, M. .....Milwaukee
Rudolph, W. H.....Milwaukee
Ruegsegger, W. O.....South Wayne
Ruesch, A. B.....Watertown
Sackett, W. W.....Fond du Lac
Sands, H. W.....Green Bay
Sayles, J. W.....Wisconsin Rapids
Schmitz, A. L.....Milwaukee
Schneider, W. A.....Milwaukee
Schulze, H. W.....Milwaukee
Schwingle, C. J.....Muscoda
Seger, E. A.....Merrill
Sherman, W. A.....Milwaukee
Sigler, B. E.....Waupun
Simon, E. J.....So. Kaukauna
Singleton, T. J.....Milwaukee
Slater, A. J.....Milwaukee
Stehling, C. A.....Milwaukee
Stenicka, R. F.....Milwaukee
Stroman, H. W.....Milwaukee
Sylwulka, V. S.....Park Falls
Teubner, W. A.....Racine

Tews, W. A. ..... Milwaukee
Thompson, E. S. ..... Wautoma
Timmers, L. E. ..... Seymour
Toner, H. J. ..... Kenosha
Vermeulen, P. J. ..... Depere
Wapp, A. L. ..... Waukesha
Weber, R. A. ..... Fond du Lac
Weickert, E. C. ..... Milwaukee
Weishan, E. G. ..... Milwaukee
Weffler, E. E. ..... Arcadia
Wenzel, E. ..... Milwaukee
White, H. D. ..... Milwaukee
Witteman, A. ..... Milwaukee

MARQUETTE UNIVERSITY

MILWAUKEE, WISCONSIN.

COLLEGE OF ARTS AND SCIENCES.

Courses in Letters, Sciences and Philosophy, leading to the Bachelor's degree in Arts and Sciences.

COLLEGE OF APPLIED SCIENCE AND ENGINEERING.

Courses in Civil, Mechanical, Chemical and Electrical Engineering, leading to Professional Degrees.

NOW USING THE CO-OPERATIVE SYSTEM.

SCHOOL OF MEDICINE.

A seven-year course leading to the degree of Bachelor of Science and Doctor of Medicine.

COLLEGE OF LAW.*

a. The Day Law School, a four-year course leading to the degree of Bachelor of Laws.

b. The evening Law School, a four-year course preparing for admission to the bar.

COLLEGE OF DENTISTRY.

A four-year course leading to the degree of Doctor of Dental Surgery. Post-Graduate and Extension Courses in Dentistry.

THE R. A. JOHNSTON COLLEGE OF ECONOMICS.*

a. A three-year course leading to the degree of Bachelor of Commercial Science.

b. A four-year course leading to the degree of Bachelor of Science in Economics.

SCHOOL OF JOURNALISM.*

a. Four-year courses leading to the degrees of Bachelor of Arts in Journalism, Bachelor of Science in Journalism, and Bachelor of Literature in Journalism.

b. A three-year course leading to the degree of Bachelor of Journalism.

TRAINING SCHOOL FOR NURSES.

Conducted in connection with Trinity Hospital. A three-year course.

MARQUETTE UNIVERSITY CONSERVATORY OF MUSIC.

Instruction in Piano, Vocal, Violin, Organ and all orchestral instruments. Theory and History of Music, Dramatic Art, Art of Expression, Public School Music, Ensemble and Sight-Reading.

MARQUETTE ACADEMY.

The University High School.

Preparatory Department, Classical and Commercial courses, Courses preparatory to Law, Medicine and Engineering.

SUMMER SCHOOL.

Six weeks' session during July and August. College of Arts and Sciences.

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* These Departments also have evening sessions.

PROFESSIONAL ETHICS

In the Engineering, as in the other professional schools of Marquette University, professional ethics is deemed an essential part of the training.

The need of sound moral principles in all the professions is now quite widely recognized.

A physician, a lawyer, an economist, or an engineer whose moral development does not compare favorably with his mental equipment can never win the confidence of his fellow men. They look askance at him and deem his presence in the community a menace to the home and a source of fear to the state.

"The present-day problem in engineering education," to quote a prominent member of the faculty of an engineering college in Iowa, "is how to educate our engineers better in the fundamentals of successful education. High qualities of manhood are absolutely essential in the engineer; so are high technical qualifications. * * *

"The engineer must pass a double test and not fail in either manhood or technical requirements. * * *

"No person should be ranked as an engineer who does not possess the qualifications of manhood in a satisfactory degree, and this requirement should be separate from and in addition to satisfactory technical qualifications."

The Faculty of Marquette University considers it necessary for the weal of the family and civil society to develop a sound sense of professional ethics within the engineering students.

Marquette University

COLLEGE OF APPLIED SCIENCE AND ENGINEERING

BULLETIN OF MARQUETTE UNIVERSITY
SERIES III. VOL. 7. NUMBER 3. MARCH, 1922.

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1922

JULY

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1923

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Marquette University

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ENGINEERING CALENDAR 1922-1923

FRESHMEN

Entrance Examinations	Sept. 7-9
Registration. First Semester	Sept. 11-12
Class Work begins	Sept. 13
Thanksgiving Recess	Nov. 30-Dec. 2
Holiday Recess	Dec. 24-Jan. 6
First Semester Examinations	Jan. 25-27
Second Semester Registration	Jan. 29-30
Condition Exams. for First Term	Feb. 9-10
Easter Recess	Mar 26-Apr. 2
Memorial Day Recess	May 30
Second Semester Examinations	May 31-June 2

UPPER CLASSMEN

	Sect. A.	Sect. B.
Registration. First Term	Sept. 11	Sept. 25
Class Work begins	Sept. 12	Sept. 26
Condition Exams for preceeding Term	Sept. 22-23	Oct. 7-8
Shop Work begins	Sept. 25	Sept. 11
Thanksgiving Recess	Nov. 16-18	Nov. 30-Dec. 2
Holiday Recess	Dec. 31-Jan. 6	Dec. 24-30
First Term Classes end	Jan. 13	Jan. 27
Second Term Registration	Jan. 29	Feb. 12
Second Term Class Work begins	Jan. 30	Feb. 13
Condition Exams. for First Term	Feb. 9-10	Feb. 24-25
Easter Recess	Mar. 30-Apr. 2	Apr. 13-16
Second Term Classes end	May 26	June 9
Summer Term Classes begin	May 28	June 11
Condition Exams. for Second Term	June 1-2	June 15-16
Summer Term Classes end	July 7	July 28
Year closes	Sept. 8	Aug. 18
Vacation	July 30-Aug. 18	Aug. 20-Sept. 8

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JOHN B. FROEBES, S. J.....Assistant Professor of Mathematics

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HAROLD B. KIERSEY, B. S. in M. E.....
.....Assistant Professor of Mechanical Engineering

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.....Assistant Professor of Mathematics

ANTHONY J. GAUCKLER, A. B., B. S. in C. E.....
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MENDEL GLICKMAN, B. S. in M. E.....
.....Instructor in Mechanical Engineering

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EDWARD W. KANE, B. S. in E. E.....
.....Instructor in Electrical Engineering

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CLIFFORD E. McDONALD, A. B.....Instructor in English

JOHN E. SHOEN, B. S. in M. E.....
.....Instructor in Mechanical Engineering

NAND SINGH, M. E.....Instructor in Chemistry

HEINE M. STOCKDER, B. S. in M. E.....
.....Instructor in Mechanical Engineering

J. HAROLD WILLIAMS, B. S. in C. and I. E.....
.....Instructor in Civil Engineering

JOSEPH D. BONNESS.....Assistant Instructor in Mathematics

ALICE L. QUINN.....Secretary to the Faculty

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...Lecturer of Technical Bureau of Portland Cement Association

F. A. CANNON, Executive Secretary, Good Roads Association of Wis.

H. A. FROMMELT.....Supervisor of Apprentices, Falk Co.

S. A. McKILLOP.....Director of Library Extension of Milwaukee

T. H. PHILLIPSON..General Manager, David White Instrument Co.

E. W. SMITH.....Chief Engineer, Nash Four Motor Co.

R. W. THURNER.....President, Thurner Heat Treating Co.

C. R. WEYMOUTH.....
.....Division Engineer, Wisconsin Highway Commission

W. M. WHITE.....
.....Engineer, Hydraulic Turbine Dept., Allis-Chalmers Co.

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ALLIS-CHALMERS MFG. CO

AVERY CO.

BRIGGS & STRATTON CO.

BUCYRUS MFG. CO.

CHAIN BELT CO.

CUTLER-HAMMER MFG. CO.

C., M. & ST. P. R. R.

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VILTER MFG. CO.

WISCONSIN BRIDGE AND IRON CO.

WISCONSIN MOTOR MFG. CO.

WISCONSIN TELEPHONE CO.

WORDEN-ALLEN CO.

DEVELOPMENT OF THE COLLEGE

The College of Applied Science and Engineering, at the start, offered to its students the four-year academic course in engineering. The school aimed to give the fundamentals of what was generally believed to be the essentials of a successful engineer, by giving a theoretical course accompanied by a practical laboratory application of the principles involved. This method of teaching was followed for a number of years until it became apparent that the requirements of the modern engineer demanded a change.

After a period of investigation, it was decided that, since Marquette University was located in the heart of one of the largest industrial centers of the United States, the practical side of the engineering course could be better taught if the student were placed in Milwaukee's industries. Co-operation with the industries was sought and secured, resulting in the establishment of the Marquette Co-operative Course in Engineering.

The marked increase in enrollment, as well as the high esteem of industrial officials for graduates trained in this method of education, indicate the public opinion regarding co-operative engineering.

Marquette University offers five year co-operative courses in Chemical, Civil, Electrical, and Mechanical Engineering.

THE CO-OPERATIVE COURSE IN ENGINEERING

The Co-operative Idea.

Co-operative engineering education means the joint participation of the teaching faculty and the co-operating industries in the training of technical men. It means, further, that these efforts are co-ordinated by the University, through its co-ordinating officer. This course represents the collective efforts of educators and employers to develop engineers who can better cope with the industrial problems of today because of actual personal contact with the existing conditions in industry.

In comparing the four-year academic course and the Marquette Co-operative Course we see two outstanding differences. First, The student, by actual contact with the industries, is educated in industrial practice and management, simultaneously with the acquiring of theoretical knowledge in the school, instead of subsequently. Second, Instead of giving

the student his course in practical training entirely within the school laboratories, as is done in the academic course, the new system takes him out into the field of the industries.

The co-operative plan is not an experiment. Its success has been fully demonstrated at the University of Cincinnati by fourteen years of operation. Since the adoption of this plan at Marquette University, other technical schools have introduced it, among them the Massachusetts Institute of Technology.

The Plan of Co-operation

The first year at Marquette University is devoted to continuous instruction in fundamental engineering subjects, during which time the student proves his ability from the standpoint of academic work. During the following summer, the student should be able to judge, from his practical work, whether he is sufficiently adapted to working conditions.

Upon returning to school at the beginning of the second year, the students are divided into groups, termed sections. The members of Section A attend school for two weeks, while members of Section B are employed at the various industries in and about Milwaukee. At the end of a two-week period Section B reports to school and Section A to work. This alternation in periods of two weeks is carried on throughout the year.

Arrangements for employment are all made by the school and the nature of the work depends largely upon the student's course of study in the University. While at work the student is in every sense an employee of the co-operative firm, subject to the firm's rules, regulations and hours, and the orders of its foremen in every respect.

The school maintains close contact with each student's progress in the industries by means of a co-ordination department. This department is the connecting link between the industries and the school and all matters of employment are referred to it.

Of the two hundred and fifty weeks of the course, one hundred and twenty are spent in school work, one hundred and twelve in the industries, and eighteen in vacations. Details of the sequence of these periods will be found in the schedule of courses, and the calendar.

Marquette University covers the same ground as other schools using the four year academic course. It accomplishes

this by arranging for the industries to teach shop-practice and by extending the time of the course. By giving a five year course with summer terms in the second, third, and fourth years, 120 weeks of school work are given as compared to 128 in the standard academic course, a difference of eight weeks. Shop work given in the average four-year academic course would aggregate more than eight weeks, so that actually more time is spent in academic work under the co-operative plan. Furthermore, it is a fact, that with two weeks of mental rest, more work is covered than was formerly done without this intermission. This is the experience of all schools using the co-operative plan.

Schedules of Study and Industrial Employment

The schedule of courses at school is so arranged as to give complete instruction in the subjects necessary to each branch of Engineering. In the first two years, great stress is laid upon the fundamentals of engineering, such as, Mathematics, English, Drawing, and the Sciences. In the last three years, the various phases of each individual course are treated in detail. In order to have the curriculum as general as possible, subjects from other departments of the College, and also from other departments of the University are included, to suit the needs of each course. Details may be found in the Schedule of Courses pages 30 to 41.

In the co-operative industries where Chemical, Electrical or Mechanical Engineering students are employed work schedules have been laid out, by these firms, which are calculated to give in about two years the practical experience most essential to engineers in that particular industry. These schedules are intended as a general working plan only since the amount of time spent in various departments of a plant depends largely upon the individual student's ability and aptitude for practical shop work.

In general, considerable time is devoted to the basic operations of a manufacturing plant, such as: foundry work, machine tool operation, assembly of the product, and test. Draughting room experience is offered to men who wish to become designers.

The plan for Civil Engineering students is necessarily more elastic since the work after one year is mostly seasona in character. Civil Engineers are required to spend approxi mately one year in structural steel shops at the beginnin of their course. They then enter various fields such as rail

way engineering, municipal improvement projects, building and bridge construction, road construction, surveys, etc.

Compensation of Co-operative Students

While the object of this system is purely educational, and the work for each student is so chosen as to give him a thorough knowledge of his particular branch of the profession, nevertheless the compensation received from his shopwork may often be the means of enabling a young man to complete his schooling. While the student is employed, as before stated, he is in every respect an employee of the firm for which he is working. He receives compensation for his work and such compensation is paid directly to him. The University necessarily cannot control completely the wages paid to its students. A minimum hourly rate has been agreed upon with co-operating industries which is considerably above the rate paid to regular shop apprentices. The amount a student may earn above this minimum rate depends, in general, upon the class of work and upon his ability. It will average about $350 per year at the present rates. It is well to point out here that nothing could so surely destroy the benefits of the co-operative plan as an effort on the part of the University to secure for its students the maximum rate of pay for any particular class of work. Experience has shown that where such maximum rates prevail the idea of educating the student and advancing him from one class of work to another is entirely lost sight of, and that in times of industrial depression the students are immediately laid off along with other high priced help.

Advantages of the Co-operative Course

It is believed pertinent to set forth here some of the reasons why the co-operative plan has taken so prominent a place in our system of engineering education.

The success of an engineer depends both upon his theoretical knowledge and on his ability to select the most efficient means for the economical solution of his problems. The latter involves not only the proper selection of material and machinery, but also the proper and efficient handling of men, who are needed in greater or smaller numbers to carry out a project. In order to accomplish this to the satisfaction of the men and the employer, the engineer must be familiar with the manners and habits of the workmen, with their way of looking at things, and at times be able to convince them that his method is right and their method is wrong. He must be able

to gain their confidence by proving to them that he is perfectly familiar with the work they are expected to do.

There is no short cut to this kind of knowledge. Only by associating with the workers and by sharing their problems can the engineer hope to become a leader. Shop training to be effective must be started early in life and should be a recognized part of engineering education.

It has been shown that intimate contact with the industries as the co-operative course gives does not lower scholastic standards. Furthermore, the co-operative system tends to build character and to broaden the student's outlook upon life through responsibilities that must be assumed at his place of employment.

This, as experience has clearly shown, gives students a better idea of the value of an education and enables them to understand better the human element in engineering.

The system is selective since men who are unfitted for practical work soon drop out. One of the criticisms leveled at our old school system is that many men spend four years acquiring an engineering education only to learn upon entering the practical field that they have chosen the wrong profession.

While it requires five years to complete the co-operative course, it must be remembered that many firms insist upon at least a two year apprentice course in their industry for men who have completed a four year course in engineering. This, in effect, extends their education to a period of six years, so there is a positive advantage from the standpoint of time alone.

It is but natural, in fact it is the adopted policy, for employers to fill vacancies in their organizations by men who are personally known to them or to their subordinates.

A student's record over a period of five years speaks for itself. It is clear that students, who have proven themselves valuable to any organization over that period of time, will be urged to remain. In any event, a good record of experience with a well-known company is certainly a valuable asset.

FACILITIES AFFORDED MARQUETTE STUDENTS

The Industries

A variety of industries is vital to the Co-operative Plan. Few cities in America are as fortunate in this respect as Mil-

waukee. Many of the largest industries of their kind are located here. The Bucyrus Company makes excavating machinery. Its products can be seen on nearly every large construction project in America. The Allis-Chalmers Mfg. Co. builds steam turbines, gas engines, oil engines, hydraulic machinery, cement and mining machinery and many kinds of electrical equipment. These products go to every part of the world.

The ships of the U. S. Navy are equipped with reduction gears built by the Falk Co. The Cutler-Hammer Mfg. Co. is the largest builder of electrical controlling devices in America. The National Brake & Electric Co. makes electrical machinery, air brakes, and gasoline locomotives. The Nash Motors Co. build a four-cylinder car here, and opportunity is afforded Marquette students to learn every phase of automobile construction.

The field of public utilities includes the local Traction Company, the Solvay Coke & Gas Works, the Telephone Company and two Railroads. Builders of electric cranes, bridges and general structural products include the Pawling & Harnischfeger Co., the Worden-Allen Co., Lakeside Bridge & Steel Co. and the Wisconsin Bridge and Iron Co.

The field of building construction is well provided for in a large city where many municipal and private projects are under way. Practically all of the large contractors find employment for Marquette students during the building season.

Road building is another important field for Civil Engineering students and Wisconsin is spending millions of dollars each year on this work.

More than thirty of Milwaukee's largest industries are cooperating with the College of Engineering of Marquette University.

Equipment

The College of Applied Science and Engineering is well supplied with laboratories for all of the courses offered. These have been equipped in each case with the necessary apparatus, machinery, etc., for the conducting of theoretical and practical tests and investigations. They are being added to yearly, it being the aim of this College to keep them at a point of practical efficiency and of such extent as to keep pace with their increasing requirements. Included among these are the Chemical, Physical, Mechanical, Electrical, Materials Test-

ing, Heat Treating laboratories; the Machine Shop, the Astronomical observatory, and the Topographic Engineering equipment. Only a brief description will be given here, rather than a detailed list of each individual piece of apparatus.

The Chemical Laboratory occupies the entire fourth floor of the Administration building, while that for Physics occupies the entire third floor of the same building. Both of these laboratories are equipped in minute detail for tests and investigations not only in the elementary courses but in the most advanced courses as well. Both have attendant lecture halls equipped for demonstrations.

The Mechanical Engineering Laboratory is located on the lower floor of the Engineering building. The equipment consists of high speed and Corliss engines, gasoline and kerosene engines, pumps, condenser, air compressor, etc. Standard tests of steam and gas engines to obtain efficiency, power, performance, fuel consumption, as well as tests for quality of steam, fuel analysis, calibrating gauges, boiler tests, etc., are regularly conducted.

The Electrical Engineering Laboratory is equipped with the various types of generators, motors, transformers, converters, and rectifiers, found in commercial practice. The power service of the laboratory includes both direct current and three phase, 60 cycle, alternating current, with the usual equipment of load rheostats, starting boxes, lamp banks, prony brakes, switchboards, etc. and a large assortment of electrical meters and auxiliaries. Facilities are available for making the standard tests for performance, efficiency, and regulation of the electrical machinery, as well as tests of special nature.

The Materials Testing Laboratory has testing machines for compression, tension and transverse loading tests up to a capacity of 200,000 lbs. It is also equipped with beam testing apparatus, extensometers, etc.; tensile testing machine for concrete; all necessary apparatus for the standard and commercial tests of concrete.

The Heat Treating Laboratory is equipped with gas and electric furnaces, cyanide and quenching baths, pyrometers, polishing apparatus, etc. Hardness tests can be made by both Brinell and Shore methods. Micro-photographs of properly prepared specimens can be taken. The equipment allows for the heat treatment and investigation of iron and steel and their alloys.

The Machine shop, consisting of lathes, shapers, milling machines, surface and cylindrical grinders, drilling machines, etc., is used for purposes of practical instruction and the building of special equipment for use in various departments. It is also possible with this as a medium to conduct time study tests and so augment courses in production engineering and industrial management.

The Astronomical Observatory is located in the Administration building and is well equipped for the ordinary observations and for student practice and study.

The Topographic Engineering equipment consists of a large assortment of Dumpy and Wye levels, transits, compass, plane table, tapes, leveling and stadia rods, and other accessories used in Plane and Advanced Surveying

Marquette also has a licensed Radio Station equipped for sending and receiving wireless telephone and telegraph messages.

Equipment Furnished by the Industries

During the past year equipment has been presented to the school through the efforts of the members of the Engineering Association. The David White Instrument Co. has presented a convertible level for use in Topographic work. The Nash Motor Co. has placed a four-cylinder engine, with transmission, in the Mechanical laboratory for experimental investigation. The Wisconsin Telephone Co. has installed a demonstration board in the Electrical laboratory for showing the equipment typical of a large city system, such as Milwaukee. The Hoffman Specialty Co. has supplied a group of air-valves of various types suitable for testing heating equipment. The Eugene Dietzgen Co. has presented an engineers' transit.

Library Facilities

The Library of the College of Applied Science and Engineering includes the current issues of our standard technical magazines, the bound volumes of same for a period of several years and many reference and hand books on various engineering subjects, in particular the transactions of the National Engineering Societies. These books are kept in a separate room set apart for this purpose, and are available for consultation. The effectiveness of the library has been greatly increased, during the past year, through the efforts of the Engineering Association. The additional library facilities afforded, those of the University and City Libraries, are so ex-

tensive that they present an almost unlimited field for special study and investigation.

The University Library contains 13,000 volumes and its circulation department, open to the student twice a week, affords an opportunity for intimate association with many standard works. The subjects represented are of general educational value.

The magnificent public library of the city of Milwaukee is three blocks distant from the College of Engineering. The main library together with its eight branches contains 325,000 volumes. The interior arrangement of the library is an ideal one for the student; he has access to all the books for consultation and study, and with proper permit may take them home.

The Science room alone has a total of 25,000 volumes. Almost any book desired covering such subjects as Natural Science, Mathematics, Physics, Electricity, Chemistry, Geology, and the applied subjects in the major branches of engineering can be obtained here.

In connection with the library there is a museum containing one of the largest mineralogical collections in the United States, affording an excellent opportunity for intimate study of rock specimens to students in Chemistry, Geology, etc.

STUDENT ACTIVITIES

The Marquette Engineering Association is an organization conducted solely by the students of the Engineering Department. The object of the association is to aid students in the correct presentation of their ideas before an assembled body and also to acquaint them with one another. The regular meetings are given over to debates, engineering reports, and discussions of leading topics of the day, and similar subjects. Monthly evening meetings are held at which the program usually includes an outside speaker. The engineering association likewise holds smokers, dances, and athletic contests for the benefit of its members.

In addition, the remaining organizations of the University are all open to the students of the engineering department. Among these are University athletics, the Band, the Glee Club, the Harlequin Club and the Literary society. The student is urged to engage in one or more of these activities.

INFORMATION

For information concerning the College of Applied Science and Engineering address the Registrar, 1115 Grand Avenue. Interested persons are urged to call at the Registrar's office whenever possible, since personal interviews are much more satisfactory than correspondence.

The office of the Registrar, first floor of the Administration building of Marquette University, 1115 Grand Avenue, is open daily from 9-12 A. M., 2-5 P. M., with the exception of Saturday afternoons, Sundays and holidays. At registration time it is also open on Saturday afternoons.

ADMISSION

I. General Statement

Testimonials

All applicants for admission to the College of Applied Science and Engineering must present satisfactory testimonials of good moral character.

Credentials

The College of Applied Science and Engineering requires for admission the satisfactory completion of a four-year course in the secondary school approved by a recognized accrediting agency or the equivalent of such a course. The major portion of the secondary school course presented by a student for admission should be definitely correlated with the curriculum to which he seeks admission.

All candidates for admission must offer fifteen units in acceptable subjects. No student will be admitted except on presentation of an official transcript of credits from the high school last attended. Credentials which are accepted for admission become the property of the University and are kept permanently on file.

Applications for admission, accompanied by proper credentials, should be presented to the Registrar at least one month before the opening of the semester, and will not be considered except by special action of the Committee on Admissions if presented later than two weeks before the opening of the semester. The University reserves the right to refuse to admit any student whose preparatory work is of such grade as to create a doubt regarding his ability to pursue college work successfully.

II. Methods of Admission

Admission to the College of Applied Science and Engineering may be obtained by one of the following methods: (1) By certificate; (2) by examination; (3) by a combination of the two methods.

(a) Admission by Certificate

Candidate for admission by certificate must be a graduate of an accredited high school.

DEFICIENCIES. No quantitative conditions are permitted. Every student must offer at the time of admission fifteen units in acceptable subjects. However, a student who offers fifteen acceptable units including the units prescribed for all curricula, but who is deficient in not more than two units in subjects prescribed only for the college or department which he wishes to enter, may be admitted to that college or curriculum, subject to the requirment that the deficiencies in question shall be removed before he may be registered for the second year's work.

A student with deficiencies must pay an extra tuition fee of $12.50 each semester in addition to the regular tuition fees.

(b) Admission by Examination

Applicants who are not entitled to enter on certificate must take entrance examinations in the entire number of units (page 24), and, if these are satisfactory, the candidate will be admitted, provided he presents supplementary evidence of preparation equivalent to that furnished by a four-year high school course. These examinations may be taken on the Thursday and Friday of the week preceding registration. Students desiring entrance examinations should inform the Registrar of the fact at least a week before the dates noted above.

Certificates of successful examinations before the College Entrance Examination Board will be accepted in lieu of matriculation examinations conducted by the University.

(c) Admission by Examination and Certificate

An applicant who has not been graduated from an accredited high school must pass entrance examinations in the following subjects amounting to five units:

English .....1 unit
Algebra .....1 unit
Additional subjects to be designated by the Committee on Admission.....3 units

Total .....5 units

The remaining ten units necessary to make up the fifteen units required for admission may also be made up in entrance examinations or may be offered by certificate from an accredited school.

(d) Admission on Probation

Graduates of four-year non-accredited high schools in Wisconsin will be admitted without examination on probation for one semester on the special recommendation of the principal, provided such graduates in their high school course have satisfied fully the requirements for admission to the University, and have maintained a standing of ten per cent above the passing mark in their preparatory work.

Graduates of other secondary schools outside of Wisconsinsin not accredited by a recognized standardizing body will be admitted on probation for one semester on the special recommendation of the high school principal provided (a) that such school is accredited by the state university or other recognized university or college within the state; (b) that the minimum admission requirements of Marquette University be fulfilled both as regards the amount, character, and quality of the work.

Admission to Advanced Standing

Matriculated students may secure advanced standing either by examination or by presenting credits.

I. Colleges and Universities

(a) By Examination

Advanced standing will be granted only by examination unless applicant is from an approved college. These examinations are given without fee if taken within sixty days after matriculation; if taken later, a fee of five dollars is charged for each examination.

(b) By Transcript of Record

Candidates for admission from institutions of collegiate

rank of recognized standing may be granted the same standing as at the former institution upon presenting in advance of registration:

1. A certificate of honorable dismissal.

2. An official transcript of college credits, with specifications of courses and year when taken, hours, and grades.

3. An official certified statement of entrance credits and conditions, showing the length of each course in weeks, the number of recitations and laboratory exercises, each week, the length of recitation and the mark secured.

4. A marked copy of the catalogue of the college previously attended, indicating the courses for which credit is desired.

II. Normal Schools

(a) In Wisconsin

(1) Two-year college courses. Advanced credit will be granted for college studies up to sixty credits for two years' full work, provided the student, at the time of entering the normal school, was fully prepared to enter the Freshman class of this College.

(2) Two-year professional courses. The credentials of students and graduates of these courses will be examined individually. If their preparatory studies are satisfactory, they may be given advanced standing varying from thirty to sixty credits depending on the nature and amount of work taken in the normal school.

(b) Outside Wisconsin

Students will be granted such credit as their former work entitles them, provided that, in addition to their high school and normal school certificates, they also present an official statement showing what evaluation their State University would allow for their normal school work.

III. Junior Colleges

Students from Junior Colleges will be admitted to advanced standing at this University upon fulfillment of the conditions stated above under I (a, b).

Unclassified Students

Unclassified Standing

A graduate of a four-year accredited secondary school who does not meet the requirements for admission to freshman standing may, upon recommendation of his principal, be admitted as an unclassified student. Such a student will be allowed to enroll for those courses only for which he has had adequate preparation. By virtue of his classification, he is not a candidate for a degree, but he may ultimately become a candidate for a degree by fulfilling as part of his college prescriptions all the requirements for entrance to and graduation from the college in which he is registered. An unclassified student is required to register so that all entrance deficiencies will be removed by the end of his first year of residence. Failure to comply with this requirement will render a student ineligible for readmission until all deficiencies have been removed.

Adult Special Students

The rules governing the admission of adult special students are as follows:

1. For admission to any college or school of the University, a special student must be at least twenty-one years of age.

2. A student from an accredited high school will not be admitted to this classification if he has been in attendance in the high school during the previous year.

3. All available certified credits for previous school work must be submitted to the Registrar and an application blank for admission as a special student filled out, giving, in addition to other information, the kind of work desired, the reasons for desiring such work, and, when no credits can be presented, a detailed statement of any previous educational work and practical experience.

4. By virtue of his classification, a special student is not eligible for any degree. He may ultimately become a candidate for a degree, however, by completing the admission requirements of the college in which he is registered.

5. Registration as a special student is for one semester only. Re-registration will be refused if the student has not shown satisfactory earnestness and definiteness of purpose, or if his work has not been good.

Two-year Limit. No one may register in the University as a special student for more than two years.

ENTRANCE PROCEDURE

Correspondence concerning admission should be addressed to the Registrar, Marquette University, Milwaukee, Wisconsin.

A. Credentials

Undergraduate students should send credentials by mail to the Registrar as follows:

(1) For Admission by Certificate From an Accredited School

Application forms for admission by certificate which are to be used in every case may be had on application to the Registrar. Certificates must be made out and signed by the principal or other recognized officer of the high school and mailed by him directly to the Registrar. A catalogue of the school, if published, describing the course of study in detail, should accompany the certificate. All credentials should be mailed at least one month before the beginning of the semester in order to secure prompt attention. Compliance with this request will save applicants much inconvenience.

It is expected that the principal will recommend not all graduates, but only those whose ability, application, and scholarship are so clearly marked that the school is willing to stand sponsor for their success at college. The University reserves the right to require entrance examinations in the case of candidates for admission whose certificates show grades below 80 per cent in the prescribed units. No certificate will be accepted unless the holder has spent the last year of his high school course in the school issuing the certificate.

(2) For Admission with Advanced Standing From Another Institution

Applicants for admission who have been dropped on account of poor scholarship by another institution shall not be granted advanced standing for any work done in that institution. Students from other colleges must first have met the entrance requirements of this University. The amount of advanced credit to be granted by certificate will be estimated by the Committee on Admissions and will not be written into the permanent records until the student has been in residence in the University for one semester.

B. Matriculation and Registration

(a) Students in Residence

Former students will register for the following semester on

the days announced on the bulletin boards and in the University catalogue. They will proceed to the Dean's office there to arrange their schedule for the coming semester.

(b) New Students

Procedure for new students will be as follows:

1. In case they come from a secondary school or another college they must present credentials to the Registrar and secure a certificate of admission. This should be done by correspondence as stated above. No student will be allowed to register after the first week of the semester without qualifying by the aid of an approved tutor.

2. They should matriculate in the office of the Dean of the school or college to which admission is desired. Matriculation is granted on presentation of the proper certificate of admission entitling the student to enter the University. As evidence of his membership in the University the student is given a matriculation card. This card should be retained at all times as it must be presented whenever membership in the University is to be demonstrated by the holder.

3. They will then register, in the same office, for the courses of study to be pursued during the ensuing semester. For this purpose the student will be given a registration card for the semester on which, after consultation with the Dean and with his approval, the courses desired will be entered.

4. The student will then proceed to the Bursar's office and pay the University fees for the ensuing semester. Here he shall present the matriculation card and the registration card. On payment of the fees, the Bursar will stamp the matriculation card and return it to the student, together with a receipt for tuition and other fees. Names of students will not be sent to instructors as entitled to attend classes until all fees have been paid. Students shall not receive credit for work for which they are not properly registered.

Changes in Registration

1. After the first day of the semester change of registration is permitted only (1) with the written consent of the Dean; (2) on payment of a fee of one dollar for each change thus made. In case the change is made upon the initiative of the University authorities no fee is required.

2. Change of Courses

Changes in registration must be made officially in the Dean's office and must be approved by him. This applies to courses dropped, courses added, and changing from one course to another. No change in registration may be made after the fifth week of the semester. Students who drop a study with or without permission will be marked F on the Registrar's books. If a student is permitted at his own request to drop a course after attending the class for five weeks or more, he will be given a grade of F which will become a part of the permanent records just as if he failed at the end of the course.

3. Change of Curriculum

(a) A student desiring to change from one school to another in the University must present a petition to the Registrar approved by the Deans of both Schools or both Freshman Advisers concerned in the change of course.

(b) If a minor, he must also present the written consent of his parent or guardian. The Registrar will then record the change and notify both Deans or Advisers. In the course that he enters, the student must complete all deficiencies under the direction of his Dean or Adviser.

SUBJECTS ACCEPTED FOR ENTRANCE

Candidates for admission to the Freshman class shall present entrance credits amounting to fifteen units representing four years of high school work. A unit is a series of recitations or exercises in a given subject pursued continuously throughout the school year of not less than thirty-six weeks. The number of class exercises required a week for each unit shall be five. Double periods are required for laboratory courses.

Not more than four units may be offered in any one subject. Not less than a full unit will be accepted in the first year of any language, and then only when it is followed by two units in another language. Half units will be accepted, but only when presented in addition to integral units in the same subject, or in half-year subjects which constitute a complete course in themselves, e. g., solid geometry.

Not more than three units will be accepted from the vocational group, and not more than one unit in any single subject in this group.

The major portion of the high school course offered for admission should be definitely correlated with the curriculum to

which the student seeks admission. Subjects which may be offered for entrance and the number of units which will be accepted in each subject are as follows:

Group A

Required Units

English .....3 units
Mathematics .....2 units
History .....1 unit
Science (Physics) .....1 unit

Group B

Restricted Units

Intermediate Algebra .....½ unit
Solid Geometry .....½ Unit

Group C

Elective Units

Enough electives must be chosen from this group to make, together with those from GROUP A and GROUP B, a total of twelve units. The following list shows the minimum and maximum amount of matriculation credit allowed in each subject.

Foreign Language:

Latin ..... 2—4 units
Greek ..... 1—3 units
French ..... 2—4 units
German ..... 2—4 units
Spanish ..... 2—4 units
English** ..... 1 unit

Mathematics:

Advanced Algebra .....½ unit
Solid Geometry .....½ unit
Trigonometry .....½ unit

Science:*

Biology ..... 1 unit
Chemistry ..... 1 unit
Physics ..... 1 unit
Botany .....½—1 unit

*To count as a prescribed science subject these courses must include laboratory work.

**In addition to the requirements in Group A.

Zoology	½—1 unit
Physical Geography	½—1 unit
General Science	½—1 unit
History	1—4 units
General Science	½—1 unit

Group D

Miscellaneous

The remaining three units may be selected from the commercial, industrial, or vocational subjects counted towards graduation in an accredited or recognized high school with the understanding that no subject may be presented for less than half a unit of credit, nor more than one unit of credit in any single subject in this group.

EXPENSES

The following fees are due at the beginning of the two terms at the time of registration:

	First Term	Second Term
Matriculation*	$10.00	
Tuition	$75.00	$75.00
Laboratory**	**	**
Breakage Deposit‡	$10.00	
Athletics and Gymnasium§	$15.00	
Marquette Union§	$ 5.00	
Engineering Association§	$ 1.00	$1.00

*Note.—The matriculation fee is charged every student when he applies for entrance to the University. This is charged but once and is not an annual fee.

‡Note.—A breakage fee is required only in case a Chemical course is taken, and is returnable in part when the work is completed, in accordance with the amount of breakage.

§Note.—The Athletic, Union, and Engineering Association fees are turned over to the respective organizations and entitle the student to their privileges. These include admission to the games, clubhouse privileges, and the activities of the Engineering Association.

**Note.—Laboratory fees vary in accordance with the amount of laboratory work scheduled. They may best be found from the following table:

Chem.		Phys.		Ch. E.		C. E.		E. E.	
1	$ 5.00	51	$5.00	142	$ 5.00	230	$2.50	346	$5.00
2	5.00	53	5.00	144	10.00	233	6.50	371	5.00
5	15.00	55	2.50	150	10.00	238	2.50	374	5.00
6	5.00	59	5.00	153	5.00	E. E.		M. E.	
7	5.00	Ch. E.		C. E.		321	$2.50	421	$5.00
8	5.00	122	$5.00	210	$2.50	331	5.00	432	5.00
Mech.		130	5.00	211	2.50	334	5.00	433	5.00
47	$5.00	131	5.00	220	5.00	337	2.50		
48	5.00	132	5.00	221	5.00	341	5.00		

No student will be admitted to classes until the fees for the current semester are paid. No exception will be made and students should come prepared. Tuition fees once paid cannot under any circumstances be returned. Tickets cannot be transferred. Matriculation fees once paid cannot be returned or transferred. Students agree to these conditions when paying fees.

Books and drawing instruments will cost from $40 to $50 for the Freshman year, depending upon the quality of instruments purchased. Thereafter the cost is approximately $25.00 per year.

Board and room can be obtained in close proximity to the University at from $8.00 to $11.00 per week. The student should also make due allowance for sundry personal expenses such as laundry, social activities, etc.

The average yearly return to the student from his cooperative employment is approximately $350.00. In general this is about 55 per cent of the total cost to the student.

Since the first year in each course is spent in continuous school work until the summer vacation, no income from cooperative work will accrue. However, many students are able to find employment during their first year, which will help to defray their expenses. A leaflet is issued by the University listing the opportunities found by students in previous years. This leaflet may be had upon application to the registrar.

ACADEMIC RULES AND REGULATIONS

Every student shall carry a minimum of 12 credit hours' work prescribed for the class in which he registers; otherwise he is classed as a special.

A final average below 60 for a term's work in any subject is a failure. The student will be required to repeat the work at the earliest opportunity and will not be allowed to take advanced work in the same subject or in a subject dependent upon it until he shall have made up his failure.

A final average between 60 and 70 conditions the student. A condition must be removed before the next regular offering of the subject or it becomes a failure. It will not, however, prevent the student from pursuing the advanced work. Examinations for conditions are offered in January, June and September. The student is held responsible for arranging to remove his condition. He must register for same and pay a fee of $1.00; for special condition examinations the fee is $5.00.

A final average above 70 entitles the student to credit in that subject. Credit may be withdrawn in case his subsequent work shows lack of necessary understanding, and he may be required to take such special work or repeat such sections of the subject as the Dean may prescribe.

Failure to complete certain assignments in a given subject within the prescribed time will cause an Incomplete to be granted for that subject. Failure to complete the work by the end of the succeeding term changes the Incomplete to a failure.

Reports are sent to parents or guardians at regular intervals regarding the student's standing and progress.

Failure to obtain a passing grade in one-half of the work for any one term results in a condition of probation for the succeeding term. At the end of the probation period, if he is still below passing grade in one-half of his work, the student will be dropped from the school.

Absences from class without sufficient reason are not tolerated. Upon presentation of proper reasons, the student is granted a written excuse for absence. In the case of more than 10 per cent of unexcused absences, final grade in the subject is withheld.

A change from one branch of engineering to another will only be allowed upon written application to the Dean at least one month before the close of a school term, stating clearly the reasons for desiring to make the change.

Freshmen and Sophomore students desiring to elect a subject may do so only when they have attained an average grade of 85 per cent for the preceding term's work, with no one mark below 80 per cent, or to complete a schedule in the case of conflict with the regular schedule of studies for the term.

An assessment of $3.00 will be charged for tardy registration.

Students allowed to carry more than 22 credit hours of work will be assessed at the rate of $2.50 per credit hour in excess of this number, unless such fee is paid to some other department of the University.

SHOP RULES AND REGULATIONS

Absences from shop are not tolerated. Students violating this ruling will be dealt with sternly. In the case of unavoidable absence such as severe sickness, the student must see that both the shop and the Co-ordinator of the school are notified of same on the first day of absence. On the first day of his return to work, the student must obtain a written excuse signed by the foreman and one other official at the place of employment and forward immediately to Co-ordinator. Violation of this ruling will lead to dismissal from school.

Students are subject to all rules of the shop where employed.

Unsatisfactory work in the shop is regarded by the faculty in the same light as poor work in the class room and can likewise lead to dismissal.

Leaving a place of employment or school for any reason whatsoever without the permission of both the shop and school officials places the student subject to dismissal from school and withdrawal of the year's credits.

Vacations, other than the regular shop holidays, are at all times forbidden.

Dissatisfaction with employment or any phase of it must be taken up with the Co-ordinator of the school. If this rule is judiciously adhered to, in practically every case the difficulties can be removed.

DEGREES

The University grants the professional degrees of Chemical Engineer (Ch.E.), Civil Engineer (C.E.), Electrical Engineer (E.E.), and Mechanical Engineer (M.E.), to students who have successfully completed the five-year co-operative course in any of the respective branches. These are shown in the following schedule of courses.

SCHEDULE OF COURSES
CHEMICAL ENGINEERING

FIRST YEAR

		Hrs. Per Wk. Rec.	Lab.
First Term. Eighteen Weeks of Class Work.			
Chemistry 1	General Chemistry	3	4
Drawing 10	Engineering Drawing	..	4
English 20	English and Public Speaking	3	..
Mathematics 30	Advanced Algebra	5	..
G. E. 70	Elementary Engineering	..	4
C. E. 210	Plane Surveying	1	2
C. 90	Engineering Association	..	2
Second Term. Eighteen Weeks of Class Work.			
Chemistry 2	General Chemistry	3	4
Drawing 11	Engineering Drawing	..	4
English 21	English and Public Speaking	3	..
Mathematics 31	Trigonometry	2	..
Mathematics 32	Analytic Geometry	3	..
G. E. 71	Elementary Engineering	..	4
C. E. 211	Plane Surveying	1	2
C. 91	Engineering Association	..	2

SECOND YEAR

First Term. Nine Weeks of Class Work.			
Drawing 13	Descriptive Geometry	2	4
Mathematics 33	Differential Calculus	5	..
Physics 50	Mechanics, Molecular Physics and Heat	4	..
Physics 51	Physical Measurements	..	4
Ch. E. 121	Metallurgy of Iron and Steel	4	..
C. 92	Engineering Association	..	2
Ten Weeks of Industrial Experience.			
Second Term. Nine Weeks of Class Work.			
Mathematics 34	Integral Calculus	5	..
Physics 52	Electricity, Sound, and Light	4	..
Physics 53	Physical Measurements	..	4
M. E. 420	Heat Engines	6	..
M. E. 421	Mechanical Engineering Laboratory	..	4
C. 93	Engineering Association	..	2
Ten Weeks of Industrial Experience.			

(Chemical Engineering).

		Hrs. per Wk. Rec.	Lab.
Summer Term. Four Weeks of Class Work.			
Mechanics 40	Statics	6	..
Physics 54	Electricity, Sound, and Light	5	..
Physics 55	Physical Measurements	..	4
Ch. E. 122	Fuel and Gas Analysis	..	8
	Six Weeks of Industrial Experience.		

THIRD YEAR

First Term. Nine Weeks of Class Work.			
Mechanics 41	Statics and Mechanics of Materials	5	..
Mechanics 43	Dynamics	6	..
Chemistry 5	Quantitative Analysis	..	12
M. E. 432	Mechanical Engineering Laboratory	..	4
C. 94	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		
Second Term. Nine Weeks of Class Work.			
Mechanics 42	Mechanics of Materials	6	..
Ch. E. 130	Inorganic Technical Analysis	..	4
E. E. 370	Elements of Electrical Engineering	4	..
E. E. 371	Electrical Engineering Laboratory	..	4
M. E. 435	Mechanism	2	6
C. 95	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		
Summer Term. Four Weeks of Class Work.			
Ch. E. 131	Inorganic Technical Analysis	..	8
Ch. E. 132	Iron and Steel Analysis	..	12
M. E. 439	Elements of Machine Design	..	12
	Six Weeks of Industrial Experience.		

FOURTH YEAR

First Term. Nine Weeks of Class Work.			
Chemistry 6	Organic Chemistry	3	4
Mechanics 44	Hydraulics	4	..
G. E. 72	Economics	3	..
G. E. 76	Principles of Accounting	3	..
E. E. 373	Elements of Electrical Engineering	4	..
E. E. 374	Electrical Engineering Laboratory	..	4
C. 96	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		

(Chemical Engineering).

		Hrs. per Wk. Rec.	Lab.
Second Term. Nine Weeks of Class Work.			
Chemistry 7	Organic Chemistry	3	4
Mechanics 46	Engineering Materials	3	..
Mechanics 47	Material Testing Laboratory	..	4
G. E. 73	Economics	3	..
G. E. 77	Principles of Accounting	3	..
Ch. E. 142	Metallography	2	4
C. 97	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		
Summer Term. Four Weeks of Class Work.			
Ch. E. 144	Heat Treatment of Steel	..	16
C. E. 243	Structural Design	..	16
	Six Weeks of Industrial Experience.		

FIFTH YEAR

First Term. Nine Weeks of Class Work.			
G. E. 78	Business Law for Engineers	3	..
Ch. E. 150	Organic Technical Analysis	..	8
Ch. E. 153	Applied Electro Chemistry	2	4
M. E. 450	Industrial Management	3	..
M. E. 454	Heating and Ventilating	3	4
C. 98	Engineering Association	..	2
	*Electives	2	or 4
	Ten Weeks of Industrial Experience.		
Second Term. Nine Weeks of Class Work.			
Chemistry 8	Physical Chemistry	4	4
G. E. 79	Business Law for Engineers	3	..
Ch. E. 152	Industrial Chemistry	4	..
M. E. 451	Industrial Management	3	..
C. 99	Engineering Association	..	2
	*Electives	3	or 6
	Ten Weeks of Industrial Experience.		

*Choice of electives is subject to the approval of the Head of this Department.

CIVIL ENGINEERING

FIRST YEAR

		Hrs. per Wk. Rec.	Lab.
First Term. Eighteen Weeks of Class Work.			
Chemistry 1	General Chemistry	3	4
Drawing 10	Engineering Drawing	..	4
English 20	English and Public Speaking	3	..
Mathematics 30	Advanced Algebra	5	..
G. E. 70	Elementary Engineering	..	4
C. E. 210	Plane Surveying	1	2
C. 90	Engineering Association	..	2
Second Term. Eighteen Weeks of Class Work.			
Chemistry 2	General Chemistry	3	4
Drawing 11	Engineering Drawing	..	4
English 21	English and Public Speaking	3	..
Mathemtaics 31	Trigonometry	2	..
Mathematics 32	Analytic Geometry	3	..
G. E. 71	Elementary Engineering	..	4
C. E. 211	Plane Surveying	1	2
C. 91	Engineering Association	..	2

SECOND YEAR

First Term. Nine Weeks of Class Work.			
Drawing 13	Descriptive Geometry	2	4
Mathematics 33	Differential Calculus	5	..
Physics 50	Mechanics, Molecular Physics and Heat	4	..
Physics 51	Physical Measurements	..	4
Ch. E. 121	Metallurgy of Iron and Steel	4	..
C. 92	Engineering Association	..	2
Ten Weeks of Industrial Experience.			
Second Term. Nine Weeks of Class Work.			
Mathematics 34	Integral Calculus	5	..
Physics 52	Electricity, Sound, and Light	4	..
Physics 53	Physical Measurements	..	4
M. E. 420	Heat Engines	6	..
M. E. 421	Mechanical Engineering Laboratory	..	4
C. 93	Engineering Association	..	2
Ten Weeks of Industrial Experience.			
Summer Term. Four Weeks of Class Work.			
Mechanics 40	Statics	6	..
Physics 54	Electricity, Sound, and Light	5	..
Physics 55	Physical Measurements	..	4
C. E. 221	Topographic Surveying	3	8
Six Weeks of Industrial Experience.			

THIRD YEAR

		Hrs. per Wk. Rec.	Lab.
	First Term. Nine Weeks of Class Work.		
Mechanics 41	Statics and Mechanics of Materials	5	..
Mechanics 43	Dynamics	6	..
C. E. 230	Advanced Surveying	2	4
C. E. 235	Theory of Structures	4	..
M. E. 432	Mechanical Engineering Laboratory	..	4
C. 94	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		
	Second Term. Nine Weeks of Class Work.		
Mechanics 42	Mechanics of Materials	6	..
Mechanics 46	Engineering Materials	3	..
C. E. 236	Theory of Structures	3	..
C. E. 238	Astronomical Observations	2	2
E. E. 370	Elements of Electrical Engineering	4	..
E. E. 371	Electrical Engineering Laboratory	..	4
C. 95	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		
	Summer Term. Four Weeks of Class Work.		
C. E. 231	Railroad Curves	6	..
C. E. 233	Railroad Location	..	20
C. E. 234	Railroad Construction and Maintenance.	6	..
	Sixteen Weeks of Industrial Experience.		

FOURTH YEAR

	First Term. Eleven Weeks of Class Work.		
Mechanics 44	Hydraulics	4	..
G. E. 72	Economics	3	..
G. E. 76	Principles of Accounting	3	..
C. E. 241	Structural Design	..	12
E. E. 373	Elements of Electrical Engineering	3	..
E. E. 374	Electrical Engineering Laboratory	..	4
C. 96	Engineering Association	..	2
	Second Term. Twelve Weeks of Class Work.		
Mechanics 47	Materials Testing Laboratory	..	4
G. E. 73	Economics	3	..
G. E. 77	Principles of Accounting	3	..
C. E. 242	Structural Design	..	4
C. E. 245	Theory of Reinforced Concrete	3	..
C. E. 249	Hydrology	3	..
C. E. 253	Highways	4	..
C. 97	Engineering Association	..	2

Summer Term. Twenty-six Weeks of Industrial Experience.

FIFTH YEAR

		Hrs. per Wk. Rec.	Lab.
First Term. Eleven Weeks of Class Work.			
Mechanics 48	Materials Testing Laboratory	..	4
G. E. 81	Business English	2	..
G. E. 84	Geology	3	..
C. E. 250	Public Water Supply	3	..
C. E. 252	Theory of Reinforced Concrete	2	..
C. E. 254	Foundations	3	..
C. E. 257	Bridge Design	..	10
C. E. 98	Engineering Association	..	2
Second Term. Twelve Weeks of Class Work.			
G. E. 75	Engineering Specifications	2	..
G. E. 78-79	Business Law for Engineers	4	..
G. E. 82	Corporation Finance	3	..
C. E. 251	Sewerage	3	..
C. E. 255	Reinforced Concrete Design	..	4
C. E. 256	Concrete Arch Design	..	4
C. 99	Engineering Association	..	2
	*Electives	4	or 8

ELECTRICAL ENGINEERING

FIRST YEAR

First Term. Eighteen Weeks of Class Work.			
Chemistry 1	General Chemistry	3	4
Drawing 10	Engineering Drawing	..	4
English 20	English and Public Speaking	3	..
Mathematics 30	Advanced Algebra	5	..
G. E. 70	Elementary Engineering	..	4
C. E. 210	Plane Surveying	1	2
C. 90	Engineering Association	..	2
Second Term. Eighteen Weeks of Class Work.			
Chemistry 2	General Chemistry	3	4
Drawing 11	Engineering Drawing	..	4
English 21	English and Public Speaking	3	..
Mathematics 31	Trigonometry	2	..
Mathematics 32	Analytic Geometry	3	..
G. E. 71	Elementary Engineering	..	4
C. E. 211	Plane Surveying	1	2
C. 91	Engineering Association	..	2

*Choice of electives is subject to the approval of the Head of this Department.

SECOND YEAR

		Hrs. per Wk. Rec.	Lab.
	First Term. Nine Weeks of Class Work.		
Drawing 13	Descriptive Geometry	2	4
Mathematics 33	Differential Calculus	5	..
Physics 50	Mechanics, Molecular Physics, and Heat	4	..
Physics 51	Physical Measurements	..	4
Ch. E. 121	Metallurgy of Iron and Steel	4	..
C. 92	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		
	Second Term. Nine Weeks of Class Work.		
Mathematics 34	Integral Calculus	5	..
Physics 52	Electricity, Sound, and Light	4	..
Physics 53	Physical Measurements	..	4
M. E. 420	Heat Engines	6	..
M. E. 421	Mechanical Engineering Laboratory	..	4
C. 93	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		
	Summer Term. Four Weeks of Class Work.		
Mechanics 40	Statics	6	..
Physics 54	Electricity, Sound, and Light	5	..
Physics 55	Physical Measurements	..	4
E. E. 320	Elementary Electric Circuits	3	..
E. E. 321	Electric Circuits Laboratory	..	4
	Six Weeks of Industrial Experience.		

THIRD YEAR

	First Term. Nine Weeks of Class Work.		
Mechanics 41	Statics and Mechanics of Materials	5	..
Mechanics 43	Dynamics	6	..
Physics 56	Electrical Measurements	..	4
E. E. 330	Elements of Electrical Engineering	4	..
E. E. 331	Electrical Engineering Laboratory	..	4
M. E. 432	Mechanical Engineering Laboratory	..	4
C. 94	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		
	Second Term. Nine Weeks of Class Work.		
Mathematics 35	Differential Equations	2	..
Mechanics 42	Mechanics of Materials	6	..
E. E. 333	Elements of Electrical Engineering	4	..
E. E. 334	Electrical Engineering Laboratory	..	4
M. E. 435	Mechanism	2	6
C. 95	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		

		Hrs. per Wk. Rec.	Lab.
	Summer Term. Four Weeks of Class Work.		
Ch. E. 122	Fuel and Gas Analysis	..	8
E. E. 335	Electrical Meters	3	..
E. E. 336	Electric Motor Applications	5	..
E. E. 337	Electrical Engineering Laboratory	..	4
E. E. 338	Elementary Electrical Computations	..	6
E. E. 339	Electrical Machinery and Apparatus	3	..
	Six Weeks of Industrial Experience.		

FOURTH YEAR

	First Term. Nine Weeks of Class Work.		
Mechanics 44	Hydraulics	4	..
G. E. 72	Economics	3	..
G. E. 76	Principles of Accounting	3	..
E. E. 340	Electrical Machinery and Apparatus	4	..
E. E. 341	Electrical Engineering Laboratory	..	4
E. E. 342	Electrical Problems	..	2
E. E. 343	Illumination	3	..
C. 96	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		
	Second Term. Nine Weeks of Class Work.		
Physics 57	Advanced Physics	3	..
G. E. 73	Economics	3	..
G. E. 77	Principles of Accounting	3	..
E. E. 344	Illumination	3	..
E. E. 345	Electrical Machinery and Apparatus	4	..
E. E. 346	Electrical Engineering Laboratory	..	4
E. E. 347	Electrical Problems	..	4
C. 97	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		
	Summer Term. Four Weeks of Class Work.		
C. E. 243	Structural Design	..	16
E. E. 348	Electrical Problems	..	6
E. E. 349	Electric Power Distribution	5	..
	Six Weeks of Industrial Experience.		

FIFTH YEAR

		Hrs. per Wk. Rec.	Lab.
	First Term. Nine Weeks of Class Work.		
G. E. 78	Business Law for Engineers	3	..
G. E. 81	Business English	2	..
E. E. 350	Electric Power Stations	4	..
E. E. 351	Telephone Engineering	4	..
E. E. 352	Theory of Electrical Design	3	..
E. E. 353	Electrical Design	..	4
C. 98	Engineering Association	..	2
	*Electives	3 or	6
	Ten Weeks of Industrial Experience.		
	Second Term. Nine Weeks of Class Work.		
Mechanics 46	Engineering Materials	3	..
Mechanics 47	Materials Testing Laboratory	..	4
G. E. 79	Business Law for Engineers	3	..
G. E. 82	Corporation Finance	4	..
E. E. 355	Electric Railways	5	..
C. 99	Engineering Association	..	2
	*Electives	3 or	6
	Ten Weeks of Industrial Experience.		

MECHANICAL ENGINEERING.

FIRST YEAR

	First Term. Eighteen Weeks of Class Work.		
Chemistry 1	General Chemistry	3	4
Drawing 10	Engineering Drawing	..	4
English 20	English and Public Speaking	3	..
Mathematics 30	Advanced Algebra	5	..
G. E. 70	Elementary Engineering	..	4
C. E. 210	Plane Surveying	1	2
C. 90	Engineering Association	..	2
	Second Term. Eighteen Weeks of Class Work.		
Chemistry 2	General Chemistry	3	4
Drawing 11	Engineering Drawing	..	4
English 21	English and Public Speaking	3	..
Mathematics 31	Trigonometry	2	..
Mathematics 32	Analytic Geometry	3	..
G. E. 71	Elementary Engineering	..	4
C. E. 211	Plane Surveying	1	2
C. 91	Engineering Association	..	2

*Choice of electives is subject to the approval of the Head of this Department.

SECOND YEAR

(Mechanical Engineering).

		Hrs. per Wk. Rec.	Lab.
	First Term. Nine Weeks of Class Work.		
Drawing 13	Descriptive Geometry	2	4
Mathematics 33	Differential Calculus	5	..
Physics 50	Mechanics, Molecular Physics, and Heat	4	..
Physics 51	Physical Measurements	..	4
Ch. E. 121	Metallurgy of Iron and Steel	4	..
C. 92	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		
	Second Term. Nine Weeks of Class Work.		
Mathematics 34	Integral Calculus	5	..
Physics 52	Electricity, Sound, and Light	4	..
Physics 53	Physical Measurements	..	4
M. E. 420	Heat Engines	6	..
M. E. 421	Mechanical Engineering Laboratory	..	4
C. 93	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		
	Summer Term. Four Weeks of Class Work.		
Mechanics 40	Statics	6	..
Physics 54	Electricity, Sound, and Light	5	..
Physics 55	Physical Measurements	..	4
Ch. E. 122	Fuel and Gas Analysis	..	8
	Six Weeks of Industrial Experience.		

THIRD YEAR

	First Term. Nine Weeks of Class Work.		
Mechanics 41	Statics and Mechanics of Materials	5	..
Mechanics 43	Dynamics	6	..
M. E. 430	Thermodynamics	5	..
M. E. 431	Mechanical Engineering Problems	..	4
M. E. 432	Mechanical Engineering Laboratory	..	4
C. 94	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		
	Second Term. Nine Weeks of Class Work.		
Mechanics 42	Mechanics of Materials	6	..
E. E. 370	Elements of Electrical Engineering	4	..
E. E. 371	Electrical Engineering Laboratory	..	4
M. E. 433	Mechanical Engineering Laboratory	..	4
M. E. 435	Mechanism	2	6
C. 95	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		

		Hrs. per Wk. Rec.	Lab.
	Summer Term. Four Weeks of Class Work.		
Ch. E. 132	Iron and Steel Analysis	..	12
E. E. 336	Electric Motor Applications	5	..
M. E. 439	Elements of Machine Design	..	12
	Six Weeks of Industrial Experience.		

FOURTH YEAR

	First Term. Nine Weeks of Class Work.		
Mechanics 44	Hydraulics	4	..
G. E. 72	Economics	3	..
G. E. 76	Principles of Accounting	3	..
E. E. 373	Elements of Electrical Engineering	4	..
E. E. 374	Electrical Engineering Laboratory	..	4
M. E. 440	Machine Design	..	8
C. 96	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		
	Second Term. Nine Weeks of Class Work.		
Mechanics 46	Engineering Materials	3	..
Mechanics 47	Materials Testing Laboratory	..	4
Physics 57	Advanced Physics	3	..
G. E. 73	Economics	3	..
G. E. 77	Principles of Accounting	3	..
Ch. E. 142	Metallography	2	4
M. E. 441	Advanced Machine Design	1	4
C. 97	Engineering Association	..	2
	Ten Weeks of Industrial Experience.		
	Summer Term. Four Weeks of Class Work.		
Ch. E. 144	Heat Treatment of Steel	..	16
C. E. 243	Structural Design	..	16
	Six Weeks of Industrial Experience.		

FIFTH YEAR

	First Term. Nine Weeks of Class Work.		
G. E. 78	Business Law for Engineers	3	..
G. E. 80	Credits and Collections	3	..
G. E. 81	Business English	2	..
M. E. 450	Industrial Management	3	..
M. E. 452	Production Engineering	3	..
M. E. 454	Heating and Ventilating	3	..
M. E. 455	Heating and Ventilating Design	..	4
C. 98	Engineering Association	..	2
	*Electives	2	or 4
	Ten Weeks of Industrial Experience.		

*Choice of electives is subject to the approval of the Head of this Department.

		Hrs. per Wk. Rec.	Lab.
	Second Term. Nine Weeks of Class Work.		
G. E. 79	Business Law for Engineers	3	..
G. E. 82	Corporation Finance	4	..
E. E. 362	Factory Lighting	3	..
M. E. 451	Industrial Management	3	..
M. E. 453	Production Engineering	3	..
C. 99	Engineering Association	..	2
	*Electives	3	or 6
	Ten Weeks of Industrial Experience.		

DESCRIPTION OF COURSES.

Chemistry

Chemistry 1.—General Chemistry. Two lectures, one recitation, and two two-hour laboratory periods. A study of the fundamental laws and theories; the non-metallic elements and their important compounds.

Chemistry 2.—General Chemistry. Two lectures, one recitation, and two two-hour laboratory periods. The chemistry of the metallic elements and their compounds; the application of chemical theory to the formation of insoluble compounds; the separation of bases and acids; the solution and analysis of salts and alloys. Prerequisite, Chemistry 1.

Chemistry 5.—Quantitative Analysis. Three four-hour laboratory and class room periods. Under gravimetric methods are included a study of the balance, and determinations of basic and acid constituents selected to illustrate different conditions of precipitation, washing, drying, decomposition, and weighing of precipitates. Under volumetric methods are included a study of burettes and their calibration, indicators, standardization of solutions. A selected number of acidimetric, oxidimetric, and precipitation determinations are assigned. Prerequisite, Chemistry 2.

Chemistry 6.—Organic Chemistry. Two lectures, one recitation, and one four-hour laboratory period. The general principles and theories of organic chemistry; physical and chemical properties of the compounds of the open chain series. Prerequisites, Chemistry 1, 2.

Chemistry 7.—Organic Chemistry. Two lectures, one recitation, and one four-hour laboratory period. Continuation of Course 6. Physical and chemical properties of the compounds of the closed chain series. Prerequisites, Chemistry 1, 2.

Chemistry 8.—Physical Chemistry. Four lectures and one four-hour laboratory period. The physico-chemical relations. The general principles of chemistry are studied and closely correlated with the laboratory work. The practical applications of the subject are emphasized. Prerequisites, Chemistry 5, 7.

Drawing

Drawing 10.—Elementary Drawing. Four hours drawing room work per week. The course consists of practice in the use of drawing instruments, and practice in free hand lettering.

Drawing 11.—Advanced Drawing. Four hours drawing room work per week. A continuation of Drawing 10. Working drawings and tracings of models are made. The subject of Descriptive Geometry is begun with problems relating to the point, line, and plane. Prerequisite, Drawing 10.

Drawing 13.—Descriptive Geometry. One lecture, one recitation, and four drawing room hours per week. This is a systematic study of orthographic projections, applied to problems involving the representation of geometrical solids, curved and warped surfaces, their intersections and developments. Problems are assigned for home work. Prerequisite, Drawing 11.

Electives

Electives are offered under all of the following headings: Physics, General Engineering, Chemical Engineering, Civil Engineering, Electrical Engineering, and Mechanical Engineering. In addition courses may be taken in other Colleges of the University, with the approval of the Heads of the Departments.

English

English 20.—English and Public Speaking. Three class hours per week. A study of the forms of expression, chief stress being laid on exposition, both oral and written.

English 21.—English and Public Speaking. Three class hours per week. Continuation of English 20. Prerequisite, English 20.

Ethics

Ethics 25.—Fundamental Ethics. Ethics and law; Morality, its relation to law, its standard; Concept of Law, natural and positive, ecclesiastical and civil; Relation of positive to natural law; Sanction of law, its source of obligation; Application to the individual family, and state; Duties of professional men.

Mathematics

Mathematics 30.—Advanced Alegbra. Five class hours per week. A brief review of negative and irrational numbers, indices, fractions, graphic and analytical discussion of linear and quadratic equations. Followed by a study of determinants, logarithms, complex numbers, solution of higher equations, introduction to series, convergence tests, undetermined co-efficients.

Mathematics 31.—Trigonometry. Two class hours per week. Elementary functions, their relations and graphs; functions of sums,

differences and multiples of angles; solutions of plane and spherical triangles; solution of pure and mixed trigonometrical equations by graphic methods. Prerequisite, Mathematics 30.

Mathematics. 32.—Analytical Geometry. Three class hours per week. A study of the properties of lines and the conic sections by means of the algebraic equations representing them. This study is extended to higher algebraic and transcendental curves wherever possible. Prerequisite, Mathematics 31.

Mathematics 33.—Differential Calculus. Five class hours per week. A study of the fundamental formulas and processes of differentiation, followed by applications to maxima and minima, inflections, evolutes and motion of bodies. Prerequisite, Mathematics 32.

Mathematics 34.—Integral Calculus. Five class hours per week. A study of the fundamental formulas and processes of integration, followed by applications to curves, surfaces, volumes and also to Mechanics. Prerequisite, Mathematics 33.

Mathematics 35.—Differential Equations. Two class hours per week. The main purpose of this course is a study of the types of equations met in the various branches and the methods for their solution; the series methods naturally lead to a full study of the hyperbolic functions. Emphasis is laid upon the practical handling of equations encountered in Electrical Engineering. Prerequisite, Mathematics 34.

Mathematics S-36.—Mathematical Laboratory. Five class hours per week. A special course in which all students, deficient in mathematics or its applications, will be placed under the individual guidance of a member of the faculty. Attendance is required until proper knowledge of the subject has been attained.

Mechanics

Mechanics 40.—Statics. Six class hours per week during the summer term. Resolution and composition of forces, couples, conditions of equilibrium, center of gravity, moment of inertia, friction, etc. Prerequisite, Mathematics 33.

Mechanics 41.—Statics and Mechanics of Materials. Five class hours per week. The first three weeks is a continuation of Mechanics 40. The mechanics of materials treats of the effects of forces in causing changes in the size, and shape of bodies. Elastic, and ultimate strength and deformation, cases of simple stress, simple and cantilever beams are covered. Prerequisite, Mechanics 40.

Mechanics 42.—Mechanics of Materials. Six class hours per week. Overhanging, fixed, and continuous beams, columns, struts, torsion of shafts, apparent combined stresses, and compound beams and columns are fully treated. Prerequisite Mechanics 41.

Mechanics 43.—Dynamics. Six class hours per week. A study of the laws of moving bodies in their relation to force, energy, and friction, illustrated by problems on the punch press, flywheels, the balancing of machinery, belts, bearings, lubrication, movement of material. Prerequisite Mathematics 33.

Mechanics 44.—Hydraulics. Four class hours per week. A study of the Mechanics of fluids, especial emphasis being given to liquids. Hydrostatics, including pressure of liquids in tanks and reservoirs, immersion and flotation is studied first. Hydrokinetics, including steady flow of water through pipes, orifices and open channels is given in latter part of the term. Prerequisite, Mechanics 43.

Mechanics 46.—Engineering Materials. Three class hours per week. A study of the properties and characteristics of materials used in construction and their manufacture. Prerequisite, Mechanics 41.

Mechanics 47.—Materials Testing Laboratory. Four laboratory hours per week. Class tests to show methods of testing and to study the strength and general characteristics of various materials used in engineering construction. Prerequisite, Mechanics 46.

Mechanics 48.—Materials Testing Laboratory. Four laboratory hours per week. A continuation of Mechanics 47 in which student performs individual tests of the various engineering materials. Prerequisite, Mechanics 47.

Physics

Physics 50.—Mechanics, Molecular Physics and Heat. Four class hours per week. A careful analysis and study of the principles and laws of physics, their development, correlation and practical application. Special emphasis is given to Mechanics. Prerequisite, Mathematics 31.

Physics 51.—Physical Measurements. Four laboratory hours per week. Quantitative determination of physical constants. Use of instruments of precision such as micrometer, microscope, cathotometer, chronograph, etc. Verification of the laws of impact, rigidity, accelerated motion, etc. Determination of specific heats, co-efficients of expansion, laws of gases, hygrometry. Prerequisite, Physics 50.

Physics 52.—Electricity, Sound and Light. Four class hours per week. Analysis and study of the principles and laws of electricity,

sound and light, and discussion of the theories which underlie the phenomena of these subjects. Emphasis is placed on the important application of the mechanics of waves and harmonic motion to these phenomena. Prerequisite, Physics 50.

Physics 53.—Physical Measurements. Four laboratory hours per week. Experiments on, the measurement of indices of refraction, magnifying power of lenses, spectrum analysis, and photometry are taken up. Some electrical experiments are, electrostatic induction, capacity of a condenser, resistance of various devices, efficiency of a motor, operation of an alternator and transformer, pyrometry.

Physics 54.—Electricity, Sound and Light. Five class hours per week during the summer term. Continuation of Physics 52. Prerequisite, Physics 52.

Physics 55.—Physical Measurements. Four laboratory hours per week during the summer term. Continuation of Physics 53. Prerequisite, Physics 53.

Physics 56.—Electrical Measurements. Four laboratory hours per week. Calibration of measuring instruments; resistance of conductors, electrolytes, dialectrics, and gases; magnetic properties of iron; inductance; capacity; high and low potentials. Prerequisite, Physics 55.

Physics 57.—Advanced Physics. Electricity and Light. Three class hours per week, with lecture demonstrations, in the second term. An advanced course in light and electricity, especial stress being placed on spectral analysis, interference, and polarization of light, and upon the electron theory, thermionic conduction and vacuum discharges. Prerequisites, Physics 54 and Physics 55.

Physics Electives

Physics 60.—Elementary Physics. Three class and two laboratory hours per week. An elementary and descriptive course to give a general idea of the principle phenomena and laws of physics. This course is given only for those students lacking the required high school credits in Physics.

Physics 61.—Advanced Physics. Mechanics and Heat. Three class hours per week. The mathematical theories of mechanics and heat as well as the refined methods of modern research are taken up; due attention is given to practical application in engineering and the industries in general. Prerequisites, Physics 54, Mathematics 34.

Physics 62.—Measurements in Sound, Heat and Light. Four laboratory hours per week. Accurate measurements are made in stationary waves, vapor tension, calorimetry, spectrometry, diffraction, polarization, and interference. Prerequisite, Physics 55.

GENERAL ENGINEERING

G. E. 70.—Elementary Engineering. Four hours per week. A series of lectures, inspection trips, and laboratory classes, designed to give Freshmen a general idea of the various fields of engineering. The more important industries in Milwaukee are visited, a close observation is expected, and reports are required. The uses of various machine tools and their adaptability for production are studied in the University shops and some practice is given in their operation.

G. E. 71.—Elementary Engineering. Four hours per week. A continuation of G. E. 70.

G. E. 72.—Economics. Three class hours per week. A study of the general principles of economics especially as it relates to engineering problems and activities.

G. E. 73.—Economics. Three class hours per week. A continuation of course G. E. 72; includes money, credit and banking, international trade and protection, distribution of proceeds to rent, wages, interest and profits. Prerequisite, G. E. 72.

G. E. 75.—Engineering Specifications. Two class hours per week. A study of the significance and requirements of engineering contracts and specifications.

G. E. 76.—Principles of Accounting. Three class hours per week. Elements of accounting, single and double entry; debits and credits; journalizing; posting and trial balance; closing books; proprietors' accounts; partnership accounts, etc.

G. E. 77.—Principles of Accounting. Three class hours per week. Advanced accounting; analytic study of the balance sheet; assets and liabilities; depreciation; capital stock; profits; surplus reserves; sinking funds; counting house methods, etc. Prerequisite, G. E. 76.

G. E. 78.—Business Law for Engineers. Three class hours per week. Contracts; negotiable instruments; agency; partnership; corporations.

G. E. 79.—Business Law for Engineers. Three class hours per week. Sales; bailments; carriers, guaranty and suretyship; insurance; real property and tenancy. Prerequisite, G. E. 78.

G. E. 80.—Credits and Collections. Three class hours per week. Forms of credit; classes of credit and credit machinery; duties and qualifications of credit man; elements of credit risk; sources of credit; information; financial statement; legal remedies of creditor; extensions, compositions and adjustments; bankruptcy; insolvency and receivership; credit safeguards.

G. E. 81.—Business English. Two class hours per week. The principles underlying every form of business English; general correspondence; sales letters; follow-up letters; circulars; reports.

G. E. 82.—Corporation Finance. Four class hours per week. A study of the organization and financial management of corporations including business promotion; principles of capitalization; means of financing an organization; determination of profits; valuation of securities; methods of consolidation; reorganization of corporations.

Electives

G. E. 83.—American Government. Three class hours per week. A study of the development and practical working of our federal, state and local governments.

G. E. 84.—Geology. Three class hours per week. A general study of the dynamic, structural, physiographic, historical and economic geology. Prerequisite, C. E. 249.

G. E. 85.—Advertising. Three class hours per week. Psychology of appeal; color; memory; inducing action; analysis of successful advertisements; the advertising agency, etc.

G. E. 86.—Practical Salesmanship and Sales Administration. Three class hours per week. Personal qualifications, tact, address, and their development; a study of the elements that make for success; knowledge of the goods to be sold; studying the prospective buyer; approach, demonstration, presentation of argument; closing the sale.

G. E. 87.—Astronomy. Three class hours per week. A descriptive course acquainting the student with the fundamental principles and facts regarding the sun, moon, planets, comets, the stellar system, including the principle constellations, nebulae, etc. Prerequisite, Mathematics 34.

G. E. 88.—Astronomy. Three class hours per week. Theory and use of the sextant, theodolite, transit and equatorial telescope. Determination of time, latitude, longitude and azimuth with portable instruments. Prerequisite, G. E. 87.

C. 90 to C. 99 inclusive. Engineering Association. Two hours per week each. This includes a report on the outside co-operative work after each work period and participation in the regular meetings of the Engineering Association.

CHEMICAL ENGINEERING COURSES

Ch. E. 121.—Metallurgy of Iron and Steel. Four class hours per week. A study of the sources of raw materials; the processes involved

in the manufacture of pig iron and steel; the constitution and properties of cast iron, carbon steel, and alloy steels.

Ch. E. 122.—Fuel and Gas Analysis. Eight laboratory hours per week in the summer term. Analysis of coal and coke, including a calorimetric determination. The application of the Orsat apparatus to the analysis of flue gases. Prerequisites, Chemistry 1 and 2.

Ch. E. 130.—Inorganic Technical Analysis. Four laboratory hours per week. The technical methods of quantitative analysis of limestone and cement. Prerequisite, Chemistry 5.

Ch. E. 131.—Inorganic Technical Analysis. Eight hours laboratory work per week in the summer term. A continuation of Ch. E. 130, including methods for the quantitative analysis of alloys.

Ch. E. 132.—Iron and Steel Analysis. Twelve laboratory hours per week in the summer term. Technical methods for determining the important constituents in cast iron, carbon and alloy steels. Prerequisites, Chemistry 3 and Ch. E. 122.

Ch. E. 142.—Metallography. Two lectures and one four-hour laboratory period per week. The diagram of thermal equilibrium, solid solutions, and the application of the phase rule to metallography. The laboratory work consists of calibration and practise in the use of metallographic equipment including the preparation and study of micro sections. Prerequisites, Ch. E. 121, Ch. E. 132.

Ch. E. 144.—Heat Treatment of Steel. Sixteen hours per week in laboratory in the summer term. A laboratory study of modern methods in heat treatment of steel. Purposes of heat treating; methods of temperature control, design of furnaces, annealing, hardening, tempering and case hardening. Prerequisite, Ch. E. 121.

Ch. E. 150.—Organic Technical Analysis. Eight hours laboratory work per week. The technical methods of analysis of organic industrial materials; their identification and application to industry. Prerequisite, Chemistry 7.

Ch. E. 152.—Industrial Chemistry. Four hours per week. Lectures, written reports and inspection trips. A study of industrial processes of chemical manufacture.

Ch. E. 153.—Applied Electro Chemistry. Two lectures and one four-hour laboratory period. The application of the principles of electro-chemical and electro-thermal reactions to the decomposition of compounds, electro-plating, and electro-quantitative chemical analysis. Prerequisites, Chemistry 5 and E. E. 370.

Electives

Ch. E. 160.—Technical Pyometry. Four hours per week. Laboratory study of high temperature measurements, calibration of thermo-couples, resistance pyrometers and the use of these instruments in industry.

Ch. E. 161.—Water Analysis. (Industrial). Fitness for boiler and other industrial uses. The softening of water.

Ch. E. 162.—Water Analysis. (Sanitary.) The analysis of potable waters. This course also includes the bacterial count and determination of the presence or absence of the bacteria of the colon group.

Ch. E. 163.—Applied Thermal Chemistry. Three class hours per week. This course includes the investigation of chemical reactions which take place at high temperatures with particular reference to metallurgical calculations. Prerequisites, Ch. E. 121.

CIVIL ENGINEERING COURSES

C. E. 210.—Plane surveying. Four hours of field work per week for the first eight weeks, followed by two class hours per week for nine weeks. Principles and usage of the tape in measuring distance, of the level in measuring differences in elevation, and of the transit in measuring horizontal and vertical angles.

C. E. 211.—Plane Surveying. Two class hours per week for the first nine weeks, followed by four hours of field work per week for eight weeks. Continuation of C. E. 210. Prerequisite, C. E. 210.

C. E. 221.—Topographic Surveying. Three class hours and eight hours of field work, during summer term. Principles and usage of the Engineers' Transit. Adjustment of Transit, Dumpy and Wye levels A detailed study of the various problems in which the transit is used such as traverse, city, land, topographic mining, and governmental surveys, miscellaneous surveying problems. Prerequisite, C. E. 211.

C. E. 230.—Advanced Surveying. Eight hours of field practice for five weeks, followed by four recitations per week for four weeks. A continuation of C. E. 221, supplemented by study and usage of the plane table. Prerequisite, C. E. 221.

C. E. 231.—Railroad Curves. Six class hours per week during summer term. A study of simple, compound, reverse and transition curves, turn-outs, cross-overs, frogs and switches. Prerequisite, C. E. 230.

C. E. 233.—Railroad Location. Twenty hours of field and office work per week during summer term. Field and office practice of

railroad location. Reconnaisance, preliminary and final line, cross-sectioning, running in simple and transition curves, turn-outs and cross-overs comprise the field work. Office work covers the paper location of final line, calculation of quantities, plotting of profile, mass diagram and calculation of dirt distribution. Prerequisite, C. E. 231 or accompanied by C. E. 231.

C. E. 234.—Railroad Construction and Maintenance. Six class hours per week during summer term. A study of the methods and materials of construction, maintenance, structures and appliances. Prerequisite, C. E. 233, or accompanied by C. E. 233.

C. E. 235.—Theory of Structures. Four class hours per week. A study of the principles involved in the determination by both graphical and analytical methods of the stresses in various types of roof and bridge trusses. Prerequisite, Mechanics 40.

C. E. 236.—Theory of Structures. Three class hours per week. Continuation of C. E. 235. Prerequisite, C. E. 235.

C. E. 238.—Astronomical Observations. Two class and two hours of field work per week. Study and practice in solar and stellar observations for determination of meridian, time, latitude and longitude; triangulation systems, barometric and precise leveling. Prerequisite, C. E. 230.

C. E. 241.—Structural Design. Twelve hours of drawing room work per week. Complete design of a wooden roof truss, a steel roof truss and railroad deck plate girder bridge. Prerequisite, C. E. 236.

C. E. 242.—Structural Design. Four hours of drawing room work per week. Continuation of C. E. 241. Prerequisite, C. E. 241.

C. E. 243.—Structural Design. Sixteen hours drawing room work per week during the summer term. A complete design of a steel roof truss is made. Given to Chemical, Electrical and Mechanical Engineering students. Prerequisite, Mechanics 41.

C. E. 245.—Theory of Reinforced Concrete. Three class hours per week. A study of the principles of reinforced concrete and their application to building design. Prerequisite, C. E. 236.

C. E. 249.—Hydrology. Three class hours per week. A study of precipitation, run-off, stream flow, evaporation, seepage, etc., as effected by topographical and geological conditions. Prerequisite, Mechanics 44.

C. E. 250.—Public Water Supply. Three class hours per week. A study of the principal features of water-works design and construction, including quantity and quality of potable water, sources of sup-

ply, design of distribution systems, reservoirs, dams and tanks. Prerequisite, Mechanics 44.

C. E. 251.—Sewerage. Three class hours per week. A study of the design and construction of sewerage systems including surveys and estimates, determination of size and capacity of sewers and the various methods of sewage disposal. Prerequisite, Mechanics 44.

C. E. 252.—Theory of Reinforced Concrete. Two class hours per week. Continuation of C. E. 245. Prerequisite, C. E. 245.

C. E. 253.—Highways. Four class hours per week. Design, construction and maintenance of highways and streets. A study of various types of pavements. Prerequisite, C. E. 230.

C. E. 254.—Foundations. Three class hours per week. A study of the theory and design of various types of foundations. Prerequisites, Mechanics 42 and C. E. 245.

C. E. 255.—Reinforced Concrete Design. Four hours of drawing room work per week. Problems in design of various types of reinforced concrete structures. Prerequisite, C. E. 252.

C. E. 256.—Concrete Arch Design. Four hours of drawing room work per week. Complete design of a reinforced concrete arch. Prerequisite, C. E. 252.

C. E. 257.—Bridge Design. Ten hours of drawing room work per week. Design of a pin-connected through truss railroad bridge. Prerequisite, C. E. 242.

Electives

C. E. 260.—Irrigation and Drainage. Two class hours per week. A study of the methods and means of irrigation, design and construction of reservoirs, canals, flumes and other irrigation works. Also a study of the principles involved in reclamation of land by drainage. Prerequisite, Mechanics 44.

C. E. 261.—City Planning. Two class hours per week. A study of the principles involved in the laying out of street systems, park systems, etc., and problems of future municipal expansion. Prerequisite, C. E. 230.

C. E. 262.—Railroad Terminals. Three class hours per week. A study of railroad terminals, including yard layouts together with structures and appliances in connection therewith. Prerequisite, C. E. 234.

C. E. 263.—Advanced Theory of Structures. Three class hours per week. A graphical and analytical study of the stresses in stat-

ically indeterminate structures, redundant members and deflections. Prerequisite, C. E. 236.

C. E. 264.—Advanced Bridge Design. Six hours office work per week. Design of movable bridges. Prerequisite, C. E. 257.

C. E. 265.—Water Power Engineering. Three class hours per week. A study of the principles involved in the consideration of a water power project, such as effects of variation of flow, head, etc., types, characteristics, selection and installation of water wheels. Prerequisite, Mechanics 44.

C. E. 266.—Reinforced Concrete Design. Eight drawing room hours per week. Design of a reinforced concrete building. Prerequisite, C. E. 245.

ELECTRICAL ENGINEERING COURSES

E. E. 320.—Elementary Electric Circuits. Three class hours per week in the summer term. An introductory study of simple electric circuits involving characteristics of conductor materials, calculation of conductor sizes, determination of voltage drop, and power losses. Prerequisites, Physics 52 and 53.

E. E. 321.—Electrical Circuits Laboratory. To accompany E. E. 320. One four hour laboratory period per week with reports in the summer term devoted to an experimental verification of laws of circuits developed in the class room.

E. E. 330.—Elements of Electrical Engineering. Four class hours per week. An introductory study of electrical machinery and its chief applications. Prerequisites, Physics 50-53 and Mathematics 33.

E. E. 331.—Electrical Engineering Laboratory. One four-hour laboratory period per week with reports. A course of some of the simpler experiments in Direct Current testing, designed to familiarize the student with connecting and operating generators and motors, and obtaining their performance characteristics.

E. E. 333.—Elements of Electrical Engineering. Four class hours per week. This is a continuation of E. E. 330. A brief treatment of Alternating Current machines is included. Prerequisite, E. E. 330.

E. E. 334.—Electrical Engineering Laboratory. Four laboratory hours per week. This is a continuation of E. E. 331. Some of the simpler tests of A. C. apparatus and motors will be made. Prerequisite, E. E. 331.

E. E. 335.—Electrical Meters. Three class hours per week in the summer term. A study of the principles of operation and application of commercial electrical instruments and meters. Consideration is given to the application of Rules of Service of the Wisconsin Railroad Commission. Prerequisites, Physics 52, 53 and E. E. 333.

E. E. 336.—Electric Motor Applications. Five class hours per week in the summer term. This course is a detailed study of the methods of control which are essential in adapting electric motors to the conditions met with in various industries. Prerequisite, E. E. 330.

E. E. 337.—Electrical Engineering Laboratory. To accompany E. E. 335. One four hour laboratory period per week with reports in the summer term covering the calibration and testing of electrical instruments and meters. A study is made of the conditions under which meters may be properly used and the limitations to which they are subjected.

E. E. 338.—Elementary Electrical Problems. Two three hour periods per week spent in the computing room during the summer term. Elementary problems such as layout of office wiring, and design of a motor regulating rheostat will be assigned. Prerequisite, E. E. 330.

E. E. 339.—Electrical Machinery and Apparatus. Three class hours per week in the summer term. This course begins a detailed quantitative study of the various types of machinery, which extends for one year. In the summer term the Electric and Magnetic Circuits will be considered. The subjects of Generators, Motors, Transformers and Converters are then considered in order, from both the designer's and operator's point of view. Prerequisites, E. E. 330 and E. E. 331.

E. E. 340.—Electrical Machinery and Apparatus. Four class hours per week. This course is a continuation of E. E. 339. Prerequisites, E. E. 330 and E. E. 331.

E. E. 341.—Electrical Engineering Laboratory. One four-hour laboratory period per week with reports. E. E. 340 must accompany this course. Among the experiments performed in this course are such advanced tests as the analysis of dynamo performance, efficiency from losses, and compromise testing. Prerequisites, E. E. 330 and E. E. 334

E. E. 342.—Electrical Problems. One two-hour period per week in the computing room. Continuation of E. E. 338. Layout of shop wiring, motor selection, lighting installation, and working up of test data will be carried out. Prerequisites, E. E. 330, and E. E. 333, or E. E. 339.

E. E. 343.—Illumination. Three class hours per week. This is the beginning of a two-term course on the production, modification, utilization and measurement of light. The end in view is to enable the student to understand the factors governing the choice of the kind, size, and number of lamps, their location and accessories. Prerequisites, E. E. 330 and E. E. 333 or E. E. 339.

E. E. 344.—Illumination. Three class hours per week. Continuation of E. E. 343. Prerequisite, E. E. 343.

E. E. 345.—Electrical Machinery and Apparatus. Four class hours per week. Continuation of E. E. 339 and E. E. 340. Prerequisites, E. E. 340 and E. E. 339 or E. E. 333.

E. E. 346.—Electrical Engineering Laboratory. One four-hour laboratory period per week with reports. Continuation of E. E. 341. Prerequisites, E. E. 330-334.

E. E. 347.—Electrical Problems. One four-hour period per week in the computing room. Continuation of E. E. 338 and E. E. 342. Prerequisites, E. E. 330-334.

E. E. 348.—Electrical Problems. Two three-hour periods per week in the computing room in the summer term. Continuation of E. E. 333, 342 and 347. Prerequisites, E. E. 330-334.

E. E. 349.—Electric Power Distribution. Five class hours per week in the summer term. A course beginning a year's study of the general subject of Electric Power. First, the methods of providing electric service are considered, followed by a study of power plants, and sub-stations. The subject of power costs and rates are then studied. Prerequisites, E. E. 330-334.

E. E. 350.—Electric Power Stations. Four class hours per week. A continuation of E. E. 349. Prerequisites, E. E. 330-334.

E. E. 351.—Telephone Engineering. Four class hours per week. A systematic study of the science and art of communication with particular attention to the topics of standard telephone practice, telephonic transmission and interference, machine switching, and the applications of the vacuum tube. Prerequisites, E. E. 330-334 and E. E. 339.

E. E. 352.—Theory of Electrical Design. Three class hours per week. A discussion of how the performance characteristics, heating, and efficiency of a machine depend on its size and proportions. A detailed study of how these factors determine a design is then made. Prerequisites, E. E. 339 and E. E. 340.

E. E. 353.—Electrical Design. A four-hour period in the drawing

room per week. Must be taken with E. E. 352. The design of an electric machine, and the selection of equipment for a transmission line will be undertaken. Prerequisites, E. E. 339 and E. E. 340.

E. E. 354.—Electrical Design. Four hour period in the drawing room per week. Continuation of E. E. 353. Prerequisites, E. E. 339 and E. E. 340.

E. E. 355.—Electric Railway Engineering. Five class hours per week in the second term. This course is a study of the present practice of Electric Railways. Topics such as track construction and brake equipment of chief interest to Civil and Mechanical Engineers are treated as well as purely electrical features such as control and motors. The most attention will be devoted to the topics of power consumption and schedule. Prerequisites, E. E. 330 and E. E. 334.

Electives

E. E. 360.—Electric Power Transmission. Three class hours per week in the second term. Continuation of E. E. 349 and E. E. 350. Topics such as Corona, Insulation and Arresters, determined by the high voltage; and resonance and surges, present in very long lines, will be considered. Operating characteristics will also be studied. Prerequisite, E. E. 350.

E. E. 361.—Wiring for Light and Power. Three class hours per week in the second term. Open to all students. A study of the principles underlying the State and National Fire and Safety Codes, and of customary practice in installing wiring. Prerequisites, E. E. 330 and E. E. 333, or E. E. 370 and E. E. 373.

E. E. 362.—Factory Lighting. Three class hours per week in the second term. Open to all students. A brief study of illumination in its relation to correct forms of shop installations. Prerequisites, E. E. 330 and E. E. 333, or E. E. 370 and E. E. 373.

E. E. 363.—Advanced Laboratory. One four-hour period, or more, per week, in either term, with only general supervision. An individual problem, which may be in the nature of research work, will be assigned. Intensive independent work is expected. Prerequisite, E. E. 346.

E. E. 364.—Advanced Design. One four-hour period per week in the second term. An individually assigned project, either chosen by student or assigned by instructor, such as the selection of railway motor equipment or the design of an A. C. machine. Prerequisites, E. E. 353.

E. E. 365.—Report of Current Electrical Literature. One four-hour period per week in library or equivalent in either term. A search

through the files of periodicals for articles on assigned topic, and a digest or resumé of results and conclusions found by authors. Prerequisites, E. E. 330 and E. E. 334.

E. E. 350 and 355.—Electives for C. E. and M. E. students.

Courses for Non-Electrical Students

E. E. 330-334. These courses may be taken instead of 370-374 where irregular schedules make this desirable.

E. E. 370.—Elements of Electrical Engineering. Four class hours per week in the second term. A brief study of electrical machinery with emphasis upon its applications. Motors are given considerable attention, inasmuch as the field of usefulness of each type is fully discussed. A short treatment of Alternating Current machinery is also given, in the continuation of this course given in the first term. Prerequisites, Physics 50-53 and Mathematics 33.

E. E. 371.—Electrical Engineering Laboratory. Four hours laboratory per week in the second term. A course of some of the simpler experiments in the testing of motors, generators, and other electrical machines. This course has for its object the acquainting of the student with the measurement of efficiency, and the relative behavior of different types of motors. Must be accompanied or preceded by E. E. 370. Prerequisites, Physics 50-53 and Mathematics 33.

E. E. 373.—Elements of Electrical Engineering. Four class hours per week in the first term. Continuation of E. E. 370. Prerequisite, E. E. 370.

E. E. 374.—Electrical Engineering Laboratory. Four hours laboratory per week with report. Continuation of E. E. 371. Must accompany E. E. 373 or follow it. Prerequisite, E. E. 370.

MECHANICAL ENGINEERING COURSES

M. E. 420.—Heat Engines. Six class hours per week. This course embraces a study of various types of steam boilers and power plant equipment; simple and compound engines, steam turbines, air compressors and internal combustion engines. Prerequisites, Chemistry 2 and Physics 50.

M. E. 421.—Mechanical Engineering Laboratory. Four hours per week. This is a laboratory course which runs parallel with M. E. 420 and includes the calibration of pressure gauges, thermometers, meters, calorimeter tests of steam, and practice in the use of the engine indicator. It is intended to familiarize the student with mechanical laboratory instruments.

M. E. 430.—Thermodynamics. Five class hours per week. A detailed study of gas laws, various heat cycles, entropy, temperature-entropy diagram, and applications of thermodynamics to various types of heat engines. Prerequisites, Chemistry 2, Physics 50, Mathematics 33.

M. E. 431.—Mechanical Engineering Problems. Four class hours per week. This course is supplementary to M. E. 430 and consists of a series of selected problems, involving the application of thermodynamic principles, to be worked out in the drafting room.

M. E. 432.—Mechanical Engineering Laboratory. Four hours laboratory per week. A continuation of M. E. 421, which includes tests of boiler flue gases, flow of steam through orifices, steam engine valve setting, mechanical efficiency tests of steam and gas engines, and a complete test of a power plant. Prerequisites, M. E. 420 and M. E. 421.

M. E. 433.—Mechanical Engineering Laboratory. Four hours laboratory per week. Tests to determine the operating characteristics and thermal efficiencies of steam and gas engines, air compressors, pumps, etc. Prerequisites, M. E. 430 and M. E. 432.

M. E. 435.—Mechanism. Two class hours per week and six hours per week in the drafting room. A study of velocity diagrams as applied to the motion of machine parts. Time is also devoted to the design of cams and gears. Prerequisites, Drawing 13 and Physics 50.

M. E. 439.—Elements of Machine Design. Twelve hours work in the drafting room in the summer term. A continuation of M. E. 435. The design of machine parts for strength, by the use of rational and empirical methods. Prerequisites, M. E. 435 and Mechanics 42.

M. E. 440—Machine Design. Eight hours per week in the drafting room. A continuation of M. E. 439, involving the design of some simple machine and elementary work in the design of tools for interchangeable manufacture. Prerequisites M. E. 435 and Mechanics 42.

M. E. 441.—Advanced Machine Design. One lecture and one four-hour drafting period per week. The application of dynamics to the design of machine parts with special reference to inertia forces in reciprocating machines, and methods employed in balancing these forces. Prerequisites, M. E. 440 and Mechanics 43.

M. E. 450.—Industrial Management. Three class hours per week The course deals with the various methods of modern industrial organization, cost keeping, depreciation, purchasing and storing o materials, and sales organization. Prerequisites, G. E. 72 and G. E 76, and two years shop experience.

M. E. 451.—Industrial Management. Three class hours per week. A continuation of M. E. 450, which includes the discussion of labor problems, welfare work, safety and sanitation. Prerequisites, M. E. 450.

M. E. 452.—Production Engineering. Three class hours per week. This course includes a study of shop management problems, such as: routing of products, time study and bonus systems, stock records, inspection systems, safety devices and the human element in production. Prerequisite. Two years shop experience.

M. E. 453.—Production Engineering. Three class hours per week. A continuation of course M. E. 452, which consists of numerous inspection trips and written reports on shop processes and equipment.

M. E. 454.—Heating and Ventilating. Three class hours per week. Direct and indirect steam and hot water heating, gravity systems, vacuum systems, direct air heating, ventilation, temperature and humidity control, are studied in detail. Prerequisite, M. E. 430.

M. E. 455.—Heating and Ventilating Design. Four hours laboratory per week. A design and specifications of a complete heating and ventilating system is made for a modern factory or industrial building.

Electives

M. E. 460.—Experimental Engineering. Four to eight hours per week. The assignment of an experimental investigation in the nature of research work. Investigations suggested by the student's contact with shop problems may be conducted here. Elective for fifth year M. E. students.

M. E. 461.—Advanced Machine Design. Four to six hours per week. Individual design problems for students who have decided to take up this work open to those with two years of practical shop experience. The nature of the design will conform to the student's choice of industry. Electives for fifth year M. E. students.

M. E. 462.—Power Plants. Seven hours per week. Drafting room work supplemented by lectures. A discussion of the problems involved in the selection of power plant units together with the auxiliary equipment. Each student is required to select and arrange the equipment for a complete power plant. Prerequisite, M. E. 420.

M. E. 463.—Compressed Air. Four class hours per week. A mathematical treatment of problems entering into the production, transmission, and the application of compressed air. A study is made of the air compressor with particular reference to the effect of clearance, methods of cooling, advantages of compounding, etc. Attention is

given to the hydraulic compressor, friction of air in pipes, and the air lift. Prerequisites, M. E. 420 and M. E. 430.

M. E. 464.—Refrigeration. Three class hours per week. This course is designed to give the student a working knowledge of the problems entering into the selection of a mechanical refrigeration plant, and includes a complete description of the various types of ice machines and systems of refrigeration. Prerequisites, M. E. 420 and M. E. 430.

M. E. 465.—Steam Turbines. Three hours per week. The application of thermodynamic principles to the design of steam turbines and a discussion of the various types, their adaptability for different classes of service, and a comparison with the reciprocating engine. Prerequisites, M. E. 420 and M. E. 430.

STUDENT ENROLLMENT

Of the College of Applied Science and Engineering

1921-1922

ARKANSAS

Prendergast, Wm., E.E. '25....Ft. Smith

BRAZIL

Carneiro, U., E.E. '26.....St. Paulo

BRITISH COLUMBIA

Engeset, E. A., E.E. '25.....Vancouver
Lee, L. Y., E.E. '25.....Port Coquitlam

CALIFORNIA

Chie, Joseph, E.E. '25....San Francisco
Johnson, Harold H., E.E. '24.....Nueva

CHINA

Ip, David S., E.E. '25.....Shanghai
Ma, Kai Y., E.E. '25.....Chekiang

ENGLAND

Wareing, H. F., E.E. '25.....London

GEORGIA

McLendon, W. C., Ch.E. '24.....Macon

ILLINOIS

Brugger, K. A., E.E. '25.....Dubuque
Connery, T. J., E.E. '26.....Chicago
DeHaye, J. F., E.E. '22.....Willmette
Fox, James, M.E. '22.....Griggsville
Gibbons, J. J., E.E. '22.....Hanover
Graham, S. P., M.E. '25.....Ottawa
Greensward, D., E.E. '25.....Savanna
Kopp, B. F., Ch.E. '26.....Alton
Platt, S. A., M.E. 26.....Decatur
Pryor, W. E. 'E.E. '23.....Chicago
Sedlack, A. J., E.E. '26.....Fox Lake
Sloan, J. F., M.E. '25.....Lockport
Timm, T. O., E.E. '25.....Tuscola

INDIANA

Ulrey, E. L., E.E. '25.....Indianapolis

IOWA

Brazel, Harry, E.E. '24.....Pocahontas
Carey, F. G., E.E. '24.....Pocahontas
Cordes, E. L., E.E. '24.....Waterloo
Coughlin, W. E., E.E. '23.....Melrose
Evans, Earl, C.E. '25.....Des Moines
Goodman, A. J., M.E. '22.....Rhodes
Gore, R. T., C.E. '25.....Murray
Hickey, Francis, C.E. '25.....Pocahontas
Keltz, M. P., E.E. '24.....Superior
Larson, F. A., E.E. '24.....Farmington
Linnan, F. M., C.E. '24.....Pocahontas
Prasse, W. G., M.E. '26.....Keokuk
Reilly, F. P., E.E. '23.....Emmetsburg
Walsh, Francis, E.E. '26.....Pocahontas

KANSAS

Coyne, J. F., C.E. '26.....Axtell

MEXICO

Morales, A., E.E. '26.....Guadalajara
Vega, P. J., M.E. '26.....Ahome, Sinaloa

MICHIGAN

Anderzak, R., E.E. '24.....Ludington
Basso, A. J., M.E. '25.....Ironwood
Calkins, E. H., E.E. '24.....Wayland
Cane, S. J., E.E. '23.....Ontonagon
Holdredge, R., E.E. '22.....Reading
Hydar, V., C.E. '26.....Ironwood
LaBrush, W. D., E.E. '26.....Ironwood
Lahym, R. W., M.E. '25...Traverse City
McManman, F. R., M.E. '25....Ironwood
Perrizo, P. R., Ch.E. '25.....Daggett
Petranck, J. J., E.E. '25.....Bessemer
Royal, A. B., E.E. '23.....Bay City
Slye, M. E., E.E. '24.....Trenary
Zyskowski, E. Z., E.E. '26.....Iron River

MINNESOTA

Anfang, E. L., E.E. '25.....St. Paul
Benton, A. J., E.E. '23.....Minneapolis
Conrad, M. A., M.E. '26.....Winona
Dunn, G. W., E.E. '26.....Staples
Effinger, J. A., E.E. '26.....Staples
Gulden, J. L., M.E. '25.....Austin
Hauer, Henry, E.E. '26.....Bird Island
Hirth, R. B., E.E. '23.....Long Prairie
Johnson, W. E., E.E. '26...Two Harbors
Kersten, C. J., C.E. '25.....Rochester
Maliszewski, L., Ch.E. '25.....Winona
McCorkle, C., E.E. '26.....Bird Island
McLane, W. C., C.E. '24.....Graceville
Meyer, C. J., E.E. '26.....Zumbrota
Moser, M. X., E.E. '25.....Wabasha
Norman, O. A., E.E. '22.....Ashby
Palen, J. W., E.E. '25.....Caledonia
Roetzler, F., M.E. '26.....Winona
Steffes, A. M., C.E. '25.....Rollingham
Triggs, E. O., E.E. '24.....Winona
Veranth, Jos., C.E. '24.....Ely
Voelker, E. J., C.E. '25.....Winona
Welch, G. F., C.E. '25.....Wodena

MISSOURI

O'Neil, T. G., C.E. '25.....Marceline

NEBRASKA

Rambour, George, E.E. '26.....Columbus
Rerucha, Ernest, E.E. '22.....Brainard
Roskopf, G. T., E.E. '26.....Norfolk

NEW MEXICO

Koeble, E. H., E.E. '26.....Les Vegas

NEW YORK

Goetschius, W., E.E. '23.....Stony Point

NORTH DAKOTA

Chloupek, W. V., C.E. '26.....Lanken
Johnson, J. O., E.E. '25.....Grafton
Larson, A. L., Ch.E. '25...Grand Forks
Matheny, W. A., E.E. '26.....Carrington
Nuss, P. A., C.E. '25.....Grand Forks

OHIO

Little, E. G., E.E. '24.....Zanesville
Kohler, H. W., E.E. '24.....Wapakoneta

PENNSYLVANIA

Riffle, Francis, M.E. '24.....Johnstown
Wesolowski, M., Ch.E. '26....Mt. Carmel

SOUTH DAKOTA

Cosgrove, T. F., C.E. '24.....Madison
Linster, E. F., C.E. '24.....Sisseton
Moriarty, J. D., E.E. '25.....Marion
Suhr, H. F., E.E. '24.....Milbank
Forte, V. J., M.E. '25.....Ironwood
Hare, J. J., C.E. '23.....Ishpeming
Harris, C. W., E.E. '25.....Pittsford
Harris, Sam, E.E. '26.....Stambough
Hassett, B. J., E.E. '26.....Ishpeming

WISCONSIN

Adelberg, H. H., E.E. '25.....Milwaukee
Alpine, R. L., M.E. '25.Wisconsin Rapids
Armfield, H., E.E. '26.....Fennimore
Arnold, O., E.E. '23.....Kiel
Baker, R. J., Ch.E. '25.....Milwaukee
Bannister, W. B., E.E. '23.....Milwaukee
Baranowski, S. W., C.E. '23.....Oshkosh
Barnoski, John D., E.E. '26....Marinette
Barber, J. W., Special.....Milwaukee
Barrett, L. W., M.E. '24.....Thorp
Baumbach, G. E., E.E. '23....Milwaukee
Bayerlein, R. W., M.E. '24....Milwaukee
Bentert, J. R., M.E. '23.....Milwaukee
Benyas, David, Special.....Appleton
Bergelin, M. H., E.E. '26.....Chilton
Berghammer, E. P., M.E. '23..Milwaukee
Bergin, F. J., C.E. '23.....Fond du Lac
Bergin, W. T., Ch.E. '23....Fond du Lac
Bernhard, E. F., Special.....Milwaukee
Biagi, J. M., C.E. '23.....Milwaukee
Bonness, J. D., C.E. '22.....Milwaukee
Bouchard, R. J., C.E. '24.....Suamico
Brah, S. M., C.E. '25.....Milwaukee
Branks, J. O., M.E. '23.....Janesville
Budzien, A. A., M.E. '25.....Milwaukee
Buehner, H. A., Ch.E. '25....Milwaukee
Burbach, P. H., C.E. '24.....Milwaukee
Burhop, Baldwin, C.E. '26....Cedarburg
Cheifetz, S. M.E. '22.....Milwaukee
Christopher, A., E.E. '26.....Milwaukee
Coady, A. J., M.E. '26.....Milwaukee
Conway, N. P., C.E. '24 Wisconsin Rapids
Crabb, F. A., E.E. '25.....Green Bay
Croak, W. M., C.E. '26.....Janesville
Cummisford, R. G., Ch.E. '24..Milwaukee
Curran, J. J., E.E. '26.....Green Bay
Daggett, Edwin, C.E. '26.....Marinette
Davis, M. G., C.E. '25.....Milwaukee
Dearth, E. W., Ch.E. '26.....Eau Claire
Degentesh, H. E., E.E. '23....Milwaukee
Dennett, H. F., E.E. '26.....Milwaukee
Dionne, Ephraim, E.E. '26....Milwaukee
Eck, Carl W., E.E. '26.....Osecola
Eckelman, L. J., M.E. '25.....Milwaukee
Elsen, F. C., E.E. '23.....Merrill
Engelman, O. P., Special.....Milwaukee
Evans, P. J., E.E. '26.....Mineral Point
Evenson, H. O., E.E. '24.....Minocqua
Flaherty, M. E., E.E. '25.....Mauston
Fleming, H. J., M.E. '23.....Milwaukee
Fleming, L. F., C.E. '24.....Salem
Fons, A. D., C.E. '24.....Whitefish Bay
Foscato, E., M.E. '26.....Milwaukee
Frank, L. C., M.E. '24.....Milwaukee
Frazier, R. W., C.E. '26....Fond du Lac
Frederick, A. E., C.E. '22.....Fairchild
Frentzel, H. C., M.E. '24.....Milwaukee
Freund, C. J., M.E. '22 Wisconsin Rapids
Gates, E. L., M.E. '25.....Milwaukee
Gebhard, J. P., C.E. '23.....Milwaukee
Gebrand, R. R., C.E. '26.....Madison
Gerlach, Howard, C.E. '26....Milwaukee
Gerrits, E. J., C.E. '25.....Little Chute
Gieschen, A. F., Ch.E. '23....Wauwatosa
Gieschen, H. C., E.E. '25.....Wauwatosa
Grassl, Irvin, E.E. '26.....Milwaukee
Grimes, J. W., M.E. '23.....Neenah
Grimmer, Robert, E.E. '26....Green Bay
Grogan, L. W., M.E. '23.....Milwaukee
Grosjean, H. W., M.E. '25....Milwaukee
Haase, E. L., M.E. '26.....Milwaukee
Haertel, C. F., M.E. '24.....Milwaukee
Halbach, R. H., E.E. '26.....Waterford
Hardgrove, R. G., E.E. '24..Fond du Lac
Hartman, G. L., M.E. '22.....Milwaukee
Hartman, M. C., M.E. '23.....Milwaukee
Hebard, W. J., E.E. '25.....Milwaukee
Heidingsfeld, W., C.E. '26....Milwaukee
Heipp, P. A., E.E. '26.....West Bend
Hertz, Alfred, E.E. '23.....Milwaukee
Hill, A. S., E.E. '25.....Milwaukee
Hintz, F. W., C.E. '23.....Milwaukee
Hoehl, F. B., E.E. '25.....Milwaukee
Hoffman, N. N., E.E. '24.....Milwaukee
Holyoke, B. J., E.E. '26.....Oconto
Huiras, F. R., C.E. '24.....Fredonia
Hunt, G. B., E.E. '23.....Milwaukee
Hurtgen, C. A., C.E. '23.....Kenosha
Jasper, Henry, E.E. '26..Chippewa Falls
Johnson, C. A., M.E. '23.....Eau Claire
Johnson, Henry H., E.E. '26 Beaver Dam
Johnson, W. O., E.E. '23.....Stoughton
Jones, D. C., M.E. '25.....Milwaukee
Jones, R. H., E.E. '25.....Hudson
Joys, J. E., Special.....Milwaukee
Kachel, D. T., M.E. '24.....Whitewater
Kachel, L. W., M.E. '24.....Whitewater
Kauffung, C. H., M.E. '24....Milwaukee
Kelbe, Roland, M. E. '23.....Milwaukee
Keller, Charles, Ch.E. '26....Beaver Dam
Kelly, C. A., C.E. '26.....Kaukauna
Kelly, J. G., E.E. '24.....Milwaukee
Kenney, L. M., M.E. '24.....Milwaukee
Kenning, R., C.E. '26.....Janesville
Knoell, L. F., C.E. '26.....Milwaukee
Koch, A. J., C.E. '25...Port Washington
Konwinski, H. J., E.E. '25....Milwaukee
Kroha, L. J., M.E. '25.....Milwaukee
Krippner, P. G., E.E. '23....Green Bay
Kryszewski, L. A., C.E. '23....Milwaukee
Kurath, Franz, Ch.E. '24.....Milwaukee
Lamb, E. J., M.E. '22.....Sheboygan
Larson, W. A., C.E. '24.....Marinette
Lawinger, R. W., Ch.E. '25 Mineral Point
Legler, Clarence, E.E. '26....Wauwatosa
Le May, E. A., M.E. '24.....Tomahawk
Liethen, B. J., C.E. '26.....Norrie
Linx, Robert, E.E. '26.....Milwaukee
Loock, H., E.E. '26....Wisconsin Rapids
Mackowski, M. D., M.E. '25..Beaver Dam
Mallow, A. H., C.E. '24.....Watertown
Maloney, M. C., Ch.E. '23....Sheboygan
Manteufel, L., E.E. '26.....Milwaukee
Marx, L. G., E.E. '22.....Kewaskum
Matzek, L. E., M.E. '25.....Milwaukee
McCabe, J. B., M.E. '25.....Milwaukee
McCarville, W. A., E.E. '24 Mineral Point
McClurg, C. F., E.E. '25.....Fox Lake
McLaughlin, E. J., M.E. '23...Milwaukee
Meyer, L. J., E.E. '25.....Fredonia
Meyer, R. B., C.E. '25.....Two Rivers
Miller, W. J., M.E. '25.....Fox Lake
Miotke, H. A., M.E. '25.....Milwaukee

Mirgeler, W. J., M.E. '23.....Milwaukee
Murphy, J. B., E.E. '23.....Milwaukee
Nickel, Arthur, C.E. '26.....Wauwatosa
Nolan, Francis, Ch.E. '26.....Soperton
Norton, H. M., E.E. '25.....Milwaukee
O'Neil, W. J., E.E. '26.....Lake Geneva
Parks, B. W., E.E. '25.....Park Falls
Patenaude, F., E.E. '26.....Green Bay
Pawlicki, E. H., M.E. '25.....Hurley
Pederson, H. E., C.E. '24.....Oconto
Peeples, J. A., C.E. '25.....Thorpe
Pelkey, L. A., C.E. '26.....Oconto
Peters, F. G., M.E. '24.....Milwaukee
Phelps, G. E., Special.....Oakfield
Pilon, L. A., M.E. '22.....Fond du Lac
Poehling, E., M.E. '26.....La Crosse
Powers, Paul, C.E. '24.....Fennimore
Prahl, L. M., M.E. '26.....Berlin
Rashid, J. K., E.E. '24.....Janesville
Rehfeld, H., Ch.E. '23.....Milwaukee
Reinhart, M. O., C.E. '24....Fond du Lac
Reitmeyer, W. B., E.E. '24....Milwaukee
Roblee, M. A., C.E. '26.....Milwaukee
Roy, Raymond A., C.E. '26.....
.....Wisconsin Rapids
Rudolph, W. H., Special.....Milwaukee
Ruesch, A. B., E.E. '24.....Watertown
Ryan, T. J., Ch.E. '26.....Berlin
Sackett, W. W., M.E. '23....Fond du Lac
Sager, A. W., Special.....Milwaukee
Sands, H. W., C.E. '24.....Green Bay
Sayles, J. W., C.E. '25.Wisconsin Rapids
Schildhauer, W. E., C.E. '26.New Holstein
Schmitz, A. L., M.E. '25.....Milwaukee
Schneider, W. L., Ch.E. '25...Milwaukee
Schulze, H. W., M.E. '25.....Milwaukee
Schwab, G. J., Special.....Milwaukee
Sherman, W. A., C.E. '24....Milwaukee
Sigler, B. E., M.E. '25.....Waupun
Silbernagel, F. B., M.E. '26...Milwaukee
Simmons, J. E., E.E. '26.....Corliss
Singleton, T. F., Ch.E. '25....Milwaukee
Slater, A. J., M.E. '25.....Milwaukee
Smith, M. J., E.E. '26.....Elroy
Smith, Randolph, E.E. '26.....Ogema
Stathas, P. P., E.E. '23.....Milwaukee
Stehling, C. A., M.E. '23.....Milwaukee
Stein, E. A., E.E. '26.....Oakwood
Stelling, Aaron, E.E. '26.....Osceola
Stenicka, R. F., E.E. '25.....Milwaukee
Stodola, Frank, E.E. '25.....Milwaukee
Sywulka, V. S., E.E. '25.....Park Falls
Szukalski, M., E.E. '26.....Milwaukee
Teubner, W. A., M.E. '24.....Racine
Thompson, E. S., E.E. '25.....Wautoma
Travis, J. E., C.E. '26.....Milwaukee
Van Den Wymlenberg, C., E.E. '26...
.....Wrightstown
Vermeulen, P. J., M.E. '22.....Depere
Walker, F. W., E.E. '26.....Milwaukee
Wapp, A. L., C.E. '24.....Waukesha
Walsh, E. V., C.E. '26.....Milwaukee
Weichert, E. C., C.E. '24.....Milwaukee
Wenzel, Eugene, M.E. '23.....Milwaukee
White, H. D., C.E. '25.....Milwaukee
Wiesner, Fred, E.E. '26.....Milwaukee
Wilford, Joseph, E.E. '26.....Plymouth
Williamson, C., M.E. '26.....Depere
Witteman, A., M.E. '23.....Milwaukee
Zurfluh, J., E.E. '26.....Nekoosa

MARQUETTE UNIVERSITY

MILWAUKEE, WISCONSIN

COLLEGE OF ARTS AND SCIENCES

Courses in Letters, Sciences and Philosophy, leading to the Bachelor's degree in Arts and Sciences

COLLEGE OF APPLIED SCIENCE AND ENGINEERING

Courses in Civil, Mechanical, Chemical and Electrical Engineering, leading to Professional Degrees

SCHOOL OF MEDICINE

A seven-year course leading to the degree of Bachelor of Science and Doctor of Medicine

COLLEGE OF LAW*

a. The Day Law School, a four-year course leading to the degree of Bachelor of Laws

b. The Evening Law School, a four-year course preparing for admission to the bar

COLLEGE OF DENTISTRY

A four-year course leading to the degree of Doctor of Dental Surgery
Post-Graduate and Extension Courses in Dentistry

THE R. A. JOHNSTON COLLEGE OF ECONOMICS*

A four-year course leading to the degree of Bachelor of Science in Economics

SCHOOL OF JOURNALISM*

Four-year courses leading to the degrees of Bachelor of Arts in Journalism, Bachelor of Science in Journalism, and Bachelor of Literature in Journalism

TRAINING SCHOOL FOR NURSES

Conducted in connection with Trinity Hospital. A three-year course.

MARQUETTE UNIVERSITY CONSERVATORY OF MUSIC

Instruction in Piano, Vocal, Violin, Organ and all orchestral instruments. Theory and History of Music, Dramatic Art, Art of Expression, Public School Music, Ensemble and Sight-Reading.

MARQUETTE UNIVERSITY HIGH SCHOOL

The University High School

Preparatory Department, Classical and Commercial courses, Courses prepartory to Law, Medicine and Engineering

SUMMER SCHOOL

Six weeks' session during July and August. College of Arts and Sciences

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*These Departments also have evening sessions.